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The RACCOON IN KANSAS

by

Howard J. Stains

University of Kansas
Museum of Natural History and State Biological Survey

MP 10

THE RACCOON IN KANSAS, NATURAL HISTORY, MANAGEMENT, AND ECONOMIC IMPORTANCE

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TABLE OF CONTENTS

	PAGE
INTRODUCTION	5
ACKNOWLEDGMENTS	6
METHODS	6
Field work	6
Questionnaire surveys	6
DESCRIPTION	7
SIZE AND WEIGHT	9
HABITAT	12
Vegetation	12
Water	16
Habitat in western Kansas	18
Habitat in eastern Kansas	21
DISTRIBUTION AND DENSITY	25
REPRODUCTION	28
Breeding	28
Litters	30
Sex ratio	31
DEVELOPMENT OF YOUNG	31
Coalescense of bones of skull	31
Teeth	32
Methods of aging raccoons	33
PREDATORS, PARASITES AND DISEASES	35
Predators	35
Parasites	35
Diseases	38
FEEDING HABITS AND FOOD	39
Methods of study	40
Scat-stations	40
Vegetable food	41
Vertebrate-animal food	43
Invertebrate-animal food	44
Summary of seasonal food habits	45
MOVEMENTS	52
ECONOMIC IMPORTANCE	57
Raccoon trapping	57
Raccoon hunting	58
Number of hunters	58
Hunter success	58

PAGE
Dogs 59
The hunt 59
Training season 60
Field trials 62
Restocking 62
Value of the pelt and the meat of the raccoon 62
Relation of the raccoon to agriculture 62
MANAGEMENT 63
Trapping and hunting regulations 63
Education 64
Habitat management 65
SUMMARY 66
LITERATURE CITED 67

THE RACCOON IN KANSAS, NATURAL HISTORY, MANAGEMENT, AND ECONOMIC IMPORTANCE

Introduction

The raccoon (*Procyon lotor hirtus* Nelson and Goldman) was chosen for study because of its popularity as both a fur-bearer and game animal, and because of its palatable meat. Intensive work on the raccoon was begun in the autumn of 1952 and continued through the autumn of 1954.

Until approximately 15 years ago, the raccoon had been little studied anywhere. Probably the most comprehensive study was that in Michigan by Stuewer (1943). Several Master's dissertations concerning the raccoon and its natural history are on record; these include studies in Maine by Johnson (1939); in Iowa by Giles (1939), Costa (1951) and Cabalka (1952); in Missouri by Noren (1941a) and Sanderson (1949); in Ohio by Preble (1940); in Minnesota by Schoonover (1950); in Michigan by Clark (1947); and in Virginia by Shaffer (1948), Kellner (1953) and McLaughlin (1953). A Master's dissertation by Shanks (1946) was concerned, in part, with the effects of climate on abundance of raccoons in Illinois. A Doctor's dissertation by Wood (1952) considered the ecology of the raccoon along with that of other fur-bearers. Numerous other articles published since 1938 contain valuable information on the life history and characteristics of the raccoon.

Concerning the raccoon in Kansas, Baird (1858:212) lists two raccoons which were probably taken in Kansas in 1856; Gowell (1897:121-126) reported on the myology of the hind limb; Lantz (1905b:385-386) gives a general account of the habits; a Kansas trapper, David Pugh (1920:31-33), described his methods of trapping the raccoon and also describes some of its habits. Also, the raccoon has been mentioned in several faunal lists: Knox (1875:19), Baker (1889:57), Lantz (1905a:177), Dice (1923a:44-45), 1923b: 108), Linsdale (1928:141), Hibbard (1933:235, 1944:67), Black (1937:154-155), and Cockrum (1952:241-243). Goldman (1950: 38) examined one raccoon from Kansas in connection with his taxonomic study of the genus *Procyon*. Fitch and Sandidge (1953: 321) mention the occurrence of the raccoon on the University of Kansas Natural History Reservation in northeastern Kansas.

Acknowledgements

In a study of an important game species, such as I have made, the assistance of many individuals is indispensable. I am deeply indebted to approximately 1500 raccoon hunters interviewed, and also to the 92 who volunteered to record their hunting activities and kept detailed notes on the raccoons which they hunted.

To Dr. Rollin H. Baker for his guidance in this study, and Drs. E. Raymond Hall, Henry S. Fitch and A. Byron Leonard of the Department of Zoology of the University of Kansas and Dr. Robert W. Baxter of the Department of Botany who gave time and assistance in reading and criticizing this manuscript, I am also grateful.

I am indebted also to Mr. Floyd T. Amsden and Dr. F. B. Campbell for their sympathetic support in allowing me to use their lands as areas for study; to William L. Brecheisen, Jr., who spent several days in the field with me in attempts to locate litters of raccoon; to the Kansas Forestry, Fish and Game Commission for its cooperation; to Mr. C. W. Ogle, Lawrence fur-buyer, for allowing me to examine animals which he purchased; and to my wife, Frances C. Stains, who assisted me in sending questionnaires and in numerous other ways. Fellow graduate students are also to be thanked for their numerous suggestions and criticisms. The monetary support of the State Biological Survey of Kansas made the study possible.

Methods

Field Work

From July, 1951, through November, 1954, approximately 2,550 man-hours in 38 months were spent in field study; 975 of these hours were on the Campbell Farm in Douglas County, Kansas, mostly on the area extending for one mile along the Wakarusa River. Scats and other materials were obtained at 14 stations on this farm. Movements of raccoons were investigated by means of track-counts recorded daily along the river. Scats were obtained also on Plum Thicket Farm in Barber County from seven collecting stations visited monthly or bi-monthly in 1952-53.

Several raccoons in Douglas and Anderson counties were caught by hand and tagged. Various parts of the State were visited in order to study population densities, collect scats, interview raccoon hunters and trappers, and locate den trees. The store of a fur-buyer in Lawrence was visited regularly in the trapping season. Trappers and hunters in Franklin County were interviewed in the field and data concerning their activities were obtained.

Unless otherwise indicated, photographs were taken by the author.

Questionnaire Surveys

Trapper Questionnaire.—A general questionnaire, concerned with all kinds of fur-bearers, was sent to 688 trappers in Kansas in November, 1951. Names were obtained from files of licensed trappers (1950-51 season) kept by the Kansas Forestry, Fish and Game Commission. Every tenth license-stub was used beginning with a booklet of these stubs selected at random from the files.

The questionnaire, in the form of a letter with a stamped envelope bearing a return address, was sent before the trapping season opened and provided

for comments on general activities and success. The trapper could keep a daily record of his catch in a space provided on the back of the questionnaire. At the end of the trapping season, a follow-up postcard-questionnaire identical with the original except that the space for the daily record of catch was eliminated, went to trappers who had not returned the original questionnaire. A postage-due postal card was used so that postage was paid only on those cards that were returned. After two weeks, a third questionnaire, a repeat of the postal questionnaire, went to those who still had not responded. In addition, sample individuals, who still had not responded, were interviewed.

Each name was given a code number. This number was stamped on the appropriate questionnaire, thus making it unneccessary for the trapper to sign his name.

There is a large annual turn-over of persons who purchase licenses; of the 375 persons interviewed who bought trapping licenses in 1950-51, 101 (29.6 per cent) did not purchase licenses in 1951-52. In Franklin County the turn-over was even greater; 88 trappers (48.6 per cent) who bought licenses to trap in the season of 1950-51, did not buy them for the next season, 1951-52, even though the total number of licenses sold in the County was 181 each year.

Approximately 25 per cent of the persons interviewed hunted raccoons with dogs whereas 55 per cent used traps. The remaining 20 per cent both hunted and trapped.

In analyzing returns from trappers, a formula (see Stains, 1951:11) was used which weighs the average item-participation of mail-respondents and field-interviews separately. The field-interviews weigh the more in this formula since non-respondents to the questionnaire usually outnumber respondents. Field-interviews tend to lower the sample total or average, and rightly so, because of the need of an unbiased estimate (see Cochran, 1948:58).

Raccoon-hunter Questionnaire.—In November, 1952, a questionnaire was sent to all (1458) known raccoon-hunters in Kansas and 453 (31 per cent) replied.

Cooperating Raccoon-hunter Questionnaire.—The raccoon-hunters that cooperated with me in 1952-53 were invited to cooperate in a more detailed study in the following year and 233 indicated their willingness to do so. A detailed questionnaire of five pages, designed so that the hunter could help as much as he desired, was sent in October, 1953, and one follow-up letter was sent to those hunters who had not responded by February 15, 1954. In all, 92 (39.5 per cent) of the hunters responded.

Description

The raccoon, *Procyon lotor hirtus* Nelson and Goldman, that lives in Kansas is one of 25 subspecies of *P. lotor* occurring in North and Central America. Hunters often classify local raccoons into two or more distinct "kinds" because of differences in size and color. Some names frequently used are the hill coon, the valley coon, the swamp coon, the prairie coon, the northern coon, and the southern coon. Of course these alleged kinds have no status in zoological

taxonomy. Two "kinds" of raccoons in Kansas, according to hunters, are the "valley coon" and the "hill coon" or "prairie coon." The "valley coon" is reported to have short legs, to be especially dark (almost black), to live in trees, and to have little endurance when chased by dogs. The "prairie coon" is reported to have long legs, to be pale brown, to live in holes in the ground, and to have great endurance when chased by dogs. Figure *b* of Plate 1 illustrates a litter of four young raccoons from Anderson County, Kansas; three of these raccoons are dark resembling the description of a "valley coon" and the other is light resembling the description of a "prairie coon." This artificial classification continues to receive support from hunters. A raccoon which does not conform to the description of a "valley coon" or "prairie coon" is regarded as atypical. Generally, raccoons from western Kansas, where the predominant habitat is prairie, are paler than raccoons from eastern Kansas. These western animals also may be more rangy in build and owing to the scarcity of trees, live in dens in the ground more than do raccoons in eastern Kansas.

The combination of a black mask across the face and a ringed tail serves to distinguish the raccoon from all other mammals found in Kansas. The black mask is accentuated by white bands above and below. The nose and forehead are grayish brown. The ears are entirely white except for a patch of black hairs at the posterior part of the base of each ear and are seen as white half-circles against a darker background. When viewed from the front, the raccoon's head seems to be wider than long owing to the facial markings and outward-flaring fur on the cheeks. The black mask, white facial markings and white rimmed ears tend to obscure or break-up the outline of the animal's head and perhaps are of some survival value.

The venter and upper parts of each leg have short, soft, brown underfur with a scattering of long white guard hairs; short grayish-white hair clothes the rest of each leg. Each foot is covered by a pad of tough black skin on the ventral surface. The pads on the rear feet are larger than those of the front. Each foot has five toes, and each toe has a well-developed, non-retractile claw. The print of the front foot resembles the print of a miniature human hand. The print of the larger hind foot faintly resembles the footprint of a child except that the toes are longer and are arranged in a semicircle. Tracks of both the front- and hind-feet usually are shorter than the corresponding foot because the raccoon places most of its weight on the anterior part of the foot; thus unless the animal is walking on soft earth, the front and rear footprints are approximately the same size and shape although the hind foot is the longer.

The tail is ringed with five or six black or brownish-black bands separated by bands of light reddish-brown.

The adult has forty teeth; twenty in each jaw. From front to rear, the number of teeth on each side of each jaw is: three incisors, one canine, four premolars, and two molars. The molars and the fourth upper premolar are square

and the ridges and cusps are not so well developed for meat-eating as in many other carnivores. These teeth are best adapted for grinding rather than shearing, indicating that the animal is omnivorous, eating both plant and animal materials.

The male raccoon has a baculum (penis bone) as much as five inches in length in an adult, strongly curved downward near the anterior end which has a bifurcate tip. The female sometimes possesses a somewhat similar, but smaller, bone, the os-clitoris.

Most of what is known about the internal anatomy of the raccoon, is discussed by Godman (1826:174) and Whitney and Underwood (1952a:8-10).

Size and Weight

Raccoons west of the Mississippi River, from the Canadian border south to Honduras are larger than those east of the Mississippi River (Table 1) and those on islands off both coasts of North and Central America. Goldman (1950:60) thought that the largest raccoons were of the subspecies *Procyon lotor excelsus* Nelson and Goldman that occurs in southwestern Washington, western Oregon, northeastern California, northern Nevada, and Idaho. The longest raccoon examined by me, was a female (35031 KU) from Meade County, Kansas, which measured 1180 millimeters in total length and the longest skull that I examined was a male (47992 KU) from Princeton, Colusa

Table 1*a*.

Total lengths in millimeters of adult and subadult *Procyn lotor*. Arranged according to average temperature at place of capture in January and according to distribution of animals east or west of the Mississippi River (data on size from Goldman, 1950, and from specimens in the University of Kansas Museum Natural History; average temperature for January based on Goode, 1946:12, and Kincer, 1941:704).

West of Mississippi River			East of Mississippi River			
Range in Size	Average Size	Number of Specimens	Range in Size	Average Size	Number of Specimens	Temperature
.....	880	1	.....	.....	0	4°F.–15°F.
730–920	822	24	805–837	828	3	15°F.–30°F.
760–1180	860	31	635–860	781	8	30°F.–50°F.
754–950	854	12	603–892	714	29	50°F.–68°F.
.....	.....	68	.....	.....	40	Total
.....	846	.....	.....	735	.....	Average

County, California, which measured 145.5 millimeters. Raccoons are larger in the colder regions to the north and smaller in the warmer regions to the south (see Table 2), especially east of the Mississippi River. J. A. Allen (1876:325) and Hesse, *et al.* (1937:388) wrongly thought that the reverse was true.

The weights of 559 raccoons of all ages obtained from hunters in Kansas (see Table 3) ranged from 5 to 42 pounds. Fifteen of these raccoons were reported to weigh 30 pounds or more. These were: eight of 30 pounds; three of 31 pounds; one each of 32 pounds, 35 pounds, 35 7/16 pounds, and 42 pounds. The heaviest raccoon reported in the literature is a male from Wisconsin weighing 62 pounds and 6 ounces (Scott, 1951:363).

TABLE 1*b*.

Greatest length of skull (data from same sources as listed in Table 1*a*).

WEST OF MISSISSIPPI RIVER			EAST OF MISSISSIPPI RIVER			
Range in Size	Average Size	Number of Specimens	Range in Size	Average Size	Number of Specimens	Temperature
120.4–127.1	123.8	2	.....	.....	0	4°F.–15°F.
107.7–136.5	118.1	45	110.9–117.0	114.1	3	15°F.–30°F.
109.0–145.5	119.2	52	107.0–116.0	111.7	4	30°F.–50°F.
110.3–133.0	119.6	12	93.6–123.0	110.8	25	50°F.–68°F.
.....	.....	111	.....	.....	32	TOTAL
.....	118.9	.....	.....	111.0	.....	AVERAGE

Inspection of the data in Table 3 reveals several expected trends. Average weight increases each month. This increase would be expected since many of the animals were young of the year and in the process of growing, at least until late December. The weight of an adult raccoon varies with the season; animals are heaviest in late autumn and early winter (Stuewer, 1943:215; Kellner, 1953:59) owing to an accumulation of fat. Females average two pounds lighter than males. Females in Michigan also were smaller than males (Stuewer, *loc. cit.*).

In Kansas the weights of raccoons reported by hunters averaged 3.6 pounds less from soils of low fertility than from soils of high fertility (see Table 4). The soils of lowest fertility, the planosols

TABLE 2.

Lengths in millimeters of adult and subadult *Procyon lotor*. Arranged according to average temperature at place of capture in January (data from same sources as listed in Table 1*a*).

Total Length (Body + Tail)			Greatest Length of Skull			Range of Temperature
Range in Size	Average Size	Number of Specimens	Range in Size	Average Size	Number of Specimens	
.....	880	1	120.4–127.1	123.8	2	4°F.–15°F.
730–920	822	27	107.7–136.5	117.9	48	15°F.–30°F.
635–1180	844	39	107.0–145.5	118.7	56	30°F.–50°F.
603–950	755	41	93.6–133.0	113.7	37	50°F.–68°F.

TABLE 3.

Average weights in pounds of raccoons, of unknown ages, from Kansas by months as reported by hunters.*

Month	Male		Female		Both Sexes	
	No.	Av. Wt.	No.	Av. Wt.	Total No.	Av. Wt.
October	79	16.7	43	14.9	122	15.9
November	113	18.8	80	16.3	193	17.8
December	110	18.9	69	16.8	179	18.1
January	44	19.1	21	19.4	65	19.2

* Weights seem high, and may result from the selection of adult raccoons by hunters since 58 per cent of the 559 animals weighed were reported to be adults.

and the prairie soils, are in eastern Kansas; those of highest fertility, the chernozems, browns, and chestnut soils, are in western Kansas (see page 19). Nagel (1944:8-9) writes that in Missouri in areas of high soil-fertility, raccoons are 6.5 pounds heavier than in areas of low soil-fertility. An analysis of weights of raccoons taken in Kansas from soils of low fertility *versus* those of high fertility gives

a "t" value (see Snedecor, 1946:82) that is not "significant" at the 10 per cent level. Raccoons were weighed by different methods, some of which are unknown to me. Difference in method could influence significantly any statistical treatment applied to these data.

TABLE 4.

Relation of weights of raccoons to soils in Kansas.

Soil Type	MALES		FEMALES		BOTH SEXES	
	No.	Av. Wt.	No.	Av. Wt.	Total No.	Av. Wt.
LOW FERTILITY						
Planosols	103	18.1	59	16.5	162	17.5
Prairie Soils	186	17.7	126	15.4	312	16.8
TOTAL NO.	289	.....	185	.....	474	.....
AVERAGE	.....	17.9	.....	15.8	.....	17.1
HIGH FERTILITY						
Brown Soils	4	17.0	1	14.0	5	16.4
Chernozem Soils	25	21.6	18	19.2	43	20.6
Chestnut Soils	12	22.2	14	21.1	26	21.6
TOTAL NO.	41	.....	33	.....	74	.....
AVERAGE WT.	.....	21.4	.....	19.4	.....	20.7

HABITAT

Vegetation

Vegetation is the fundamental source of food for the raccoon, plays a dominant role in both the conservation and depletion of water, and provides the animal with its principal shelter. The type of vegetation that formerly covered the "Great Prairies" of the West long has concerned historians. The distribution and numbers of trees along the streams of Kansas is of particular interest in connection with the ecology of the raccoon. Early travelers who crossed Kansas seldom kept records. The few journals which exist reveal little concerning the amount of timber present in Kansas in the past. Coronado (Winship, 1896:339-613) indicated that timber was scarce or absent in Kansas in 1541. In 1724, de Bourgmont (Margry, 1886:428-447) does not mention trees west of Junction City. Journals of Lewis and Clark (Thwaites, 1904:59-73) in 1804, Ruxton (1849:299-308) in 1847, Bennett (1906:14) in 1850, Bowles (1869:32) in 1865, and Beadle (1873:434) in 1872, describe vegetation which, except for the replacement of grassland

by farmland, is not extremely different from the plant life of today in the places where they visited.

Both Williams (1946:117) and Dickens (1928:7) estimate that no more than two per cent of the total acreage of Kansas ever was in timber although Williams believes there is less timber today than when White men settled Kansas and Dickens believes there is more. Probably there is more timber present today, principally because of the number of fruit, shade and ornamental trees and shelter vegetation which has been planted. Malin (1950:297) discusses the role played by man in the modification of the ecological setting in America and concludes that "The samples of ecological history completed indicated less fundamental change than is usually assumed by conservation propagandists." From the foregoing discussions, it seems that there has been relatively little change in the amount of timber present before and after the settlement of Kansas by European man.

In the latter part of July, 1954, I traversed the two western tiers of counties in Kansas. Stops were made at all the streams crossed and at many ponds, and notes were taken of the sign (principally tracks) of furbearers and of the amount of timber present. Table 5 lists the various streams and ponds by county, the abundance of timber and sign of raccoon found alongside each body of water. In these counties trees are few and those present are around farm-buildings or are restricted to stream-ways. In general, where trees were found, sign of raccoon was found. This correlation is perhaps indicative of permanent water in these areas.

TABLE 5.

Trees and raccoon tracks in the vicinity of streams and ponds in western Kansas in July, 1954.

County	Stream or Pond	Location	Trees	Raccoon Tracks
Rawlins	Middle Beaver Creek	9 mi. W Atwood	Abundant*	Present
Cheyenne	Plum Creek	5½ N, 1 W Saint Francis	Few	Present
	Cherry Creek	1½ N, ½ W Saint Francis	Few	Present
	S. Fork Republican R.	1 mi. W Saint Francis	Common	Present
	N. Fork Beaver Creek	5 E, 12 S Saint Francis	None	Absent
Thomas	S. Fork Solomon R.	10 mi. N Oakley	None	Present
	S. Fork Saline River	1 mi. N Oakley	Few	Absent
Sherman	S. Fork Beaver Creek	8 S Cheyenne-Sherman Co. Line	None	Absent
	S. Fork Beaver Creek	10 S Cheyenne-Sherman Co.	None	Present
	N. Fork Sappa Creek	1 N Goodland	Few	Absent
	N. Fork Smoky Hill R.	9½ mi. S Goodland	None	Absent
	N. Fork Smoky Hill R.	10 mi. S Goodland	Few	Present
Logan	Fork Middle Hackberry C.	4½ mi. NE Winona	None	Absent
	Fork Middle Hackberry C.	1½ mi. NE Winona	None	Absent
	Fork Middle Hackberry C.	3 mi. S Oakley	Rare (3)**	Absent
	Fork Smoky Hill R.	2 E Wallace-Logan Co. Line	None	Present
	Fork Smoky Hill R.	2 mi. NE McAllaster	Few	Present
	Middle Hackberry C.	8 mi. S Oakley	None	Present
	Plum Creek	14 mi. S Oakley	Few	Absent
	Branch Smoky Hill R.	19 mi. S Oakley	Rare(1)	Absent
	Smoky Hill River	22 mi. S Oakley	Few	Present
	Butte Creek	9 N Wichita-Logan Co. Line	None	Absent

TABLE 5.—*Continued.*

County	Stream or Pond	Location	Trees	Raccoon Tracks
Wallace	Fork Turtle Creek	2½ S Sherman-Wallace Co. Line	None	Absent
	Fork Turtle Creek	4½ S Sherman-Wallace Co. Line	Few	Absent
	Fork Smoky Hill R.	2½ mi. N Sharon Springs	Common	Absent
	Fork Smoky Hill R.	3 mi. E Sharon Springs	Common	Present
	Fork Smoky Hill R.	6½ mi. E Sharon Springs	None	Absent
Scott	Lake McBride	10 mi. N Scott City	Abundant	Present
	White Woman Creek	3½ mi. S Scott City	Rare (1)	Absent
	Irrigation Reservoir	4½ mi. S Scott City	None	Absent
	Dry Lake	12 S, 7 E Scott City	None	Present
Wichita	North Chalk Creek	⅛ mi. S Logan-Wichita Co. Line	Few	Present
	Fork Beaver Creek	2½ S Logan-Wichita Co. Line	None	Absent
	Beaver Creek	8 S Logan-Wichita Co. Line	None	Absent
	White Woman Creek	14½ mi. E Tribune	None	Absent
	Irrigation Reservoir	Wichita-Greeley Co. Line	None	Absent
	(unnamed) Creek	1 W, 2 S Marianthal	None	Absent
	White Woman Creek	7 mi. S Marianthal	None	Absent
	Sand Creek	10 S, 3 W Marianthal	None	Absent
Greeley	White Woman Creek	1 mi. N Tribune	None	Absent
	Dead Horse Lake	SW corner Greeley County	None	Absent
Finney	Farm Pond	17 mi. N Garden City	None	Absent
Kearny	(unnamed) Creek	9 mi. N Lakin	None	Absent
	(unnamed) Creek	5 mi. N Lakin	None	Absent
	Irrigation Reservoir	2 mi. N Lakin	None	Absent
	Great West. Irr. Ditch	1/10 mi. W Finney-Kearny Co. Line	None	Absent
	Great West. Irr. Ditch	Deerfield	Few	Absent
	Lake McKinney	4 mi. N Lakin	Few	Absent

TABLE 5.—*Concluded.*

County	Stream or Pond	Location	Trees	Raccoon Tracks
Kearny (*Concluded*)				
	Arkansas River	1½ mi. SW Lakin	Few	Absent
	Irrigation Ditch	2 mi. S Lakin	None	Absent
Hamilton	Tributary Arkansas R.	9½ mi. N Syracuse	None	Present
	Tributary Arkansas R.	3½ mi. N Syracuse	Common	Absent
	Arkansas River	½ mi. S Kendall	Common	Absent
	Tributary Arkansas R.	1 mi. W Kearny-Hamilton Co. Line	Few	Absent
	Tributary Arkansas R.	4½ mi. E Syracuse	Few	Absent
	Arkansas River	1 mi. S Syracuse	Abundant	Absent
Grant	Branch of Bear Creek	3 mi. S Grant-Kearny Co line	None	Absent
	Bear Creek	3¼ mi. S Grant-Kearny Co. line	None	Absent
	N. Fork Cimarron River	1 mi. S Ulysses	Few	Absent
Stanton	Bear Creek	3½ mi. N Johnson	None	Absent
	Sandy Arroya Creek	4½ mi. S Johnson	None	Absent
	Bear Creek (Co. Lake)	7 mi. W Manter	Few	Present
Morton	N. Fork Cimarron River	18 mi. S Johnson	None	Absent
	N. Fork Cimarron River	7 mi. W, 4 mi. S Richfield	None	Absent
	S. Fork Cimarron	7½ mi. N Elkhart	Abundant	Absent

* "Abundant" is here used to signify more than "common."
** Numerals in parantheses refer to the actual number of trees.

Kansas has been divided into vegetative and biological areas by Gates (1937 and 1940), Brumwell (1951), Cockrum (1952), Fearing (1952), and McGregor (unpublished manuscript). McGregor's map (see Fig. 1) is the most accurate from the standpoint of the vegetation and was the most useful for the present study.

Water

Permanent water is important for survival of the raccoon. Almost all streams in Kansas belong to either the Missouri River drainage system or the Arkansas River drainage system (see Schoewe, 1951: 267). Two basins without surface outlets are: (1) Scott (Modac)-

basin into which Whitewoman Creek drains, and; (2) Cheyenne Bottoms into which Blood and Deception creeks drain. Almost all of the larger streams flow northeastward or southeastward. Since raccoons occur along streams with permanent water, the number of miles of flowing streams per county is a useful index for estimating the distribution of these animals. Mileage of streams was obtained from county maps prepared by the Kansas State Highway Department at various dates from 1936 through 1942, and from a map of Kansas published by the U. S. Geological Survey in 1946. Mileage

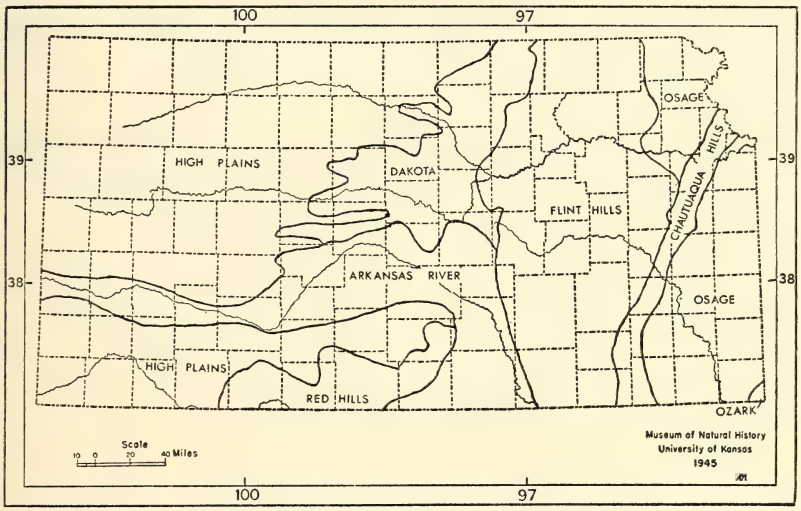

FIGURE 1. Vegetational areas in Kansas (From McGregor, 1955).

of flowing streams was calculated only from the point where the stream was indicated as being permanent on these maps unless known by the author to hold small ponds throughout the year or to be intermittent although indicated as permanent. Also, streams with a flow of less than five miles were not counted. Streams were measured by visual estimation, by comparing the length of the stream as it passed through each section of a county with one side of the section (one mile in length). Compensation was made for those streams which meander. The miles of flowing streams per square mile in each county were averaged for each vegetative area as described by McGregor (Table 6). Counties in the eastern third of the State have more miles of streams, offering favorable habitat for the raccoon, than do counties elsewhere in the State.

Farm ponds provide additional habitat for raccoons. Few ponds existed before 1930, but since then many have been built in all counties of the State, especially in eastern Kansas; in 1953 there were 80,000, approximately one per square mile (Shoewe, 1953:147 and 151), as well as 116 public artificial lakes and approximately the same number of privately owned lakes of 10 or more acres. Most of these larger impoundments are in southeastern Kansas.

Habitat in Western Kansas

Western Kansas is characterized by short grasses (buffalo and grama grasses), low rainfall, few permanent streams, soils of high fertility, and a few scattered trees restricted principally to stream-

TABLE 6.

Average linear mileage of streams per square mile in the vegetative areas of McGregor (unpublished manuscript).

Vegetative Area	Miles of Streams
High Plains	.12
Red Hills	.17
Dakota	.20
Arkansas River	.23
Flint Hills	.26
Osage	.29

ways. Wheat is the crop of first importance; grain sorghums are second in importance. The major soil-types are the brown, the chestnut, and the chernozem (see Fig. 2).

The raccoon occurs in every Kansas county; western Kansas, nevertheless, is marginal habitat. The raccoon is limited to woody areas adjacent to ponds or streams, but the animal also travels along intermittent streams from one water-hole to the next. Hunters in western Kansas have reported raccoons as far as ten miles from water. Several large irrigation ditches north of the Arkansas River, provide water attractive to raccoons. Because of frequent fluctuations in water levels and perhaps because of the fast flow of water in these ditches, aquatic invertebrates, used for food by the raccoon, are scarce. Native plants and cultivated crops including

grain sorghums and corn, which is grown most extensively in northern Kansas, are important foods for the raccoon in western Kansas. There, trees with suitable hollows for dens are rare or absent and the raccoon uses mostly openings in rocky outcrops, burrows dug by badgers and other mammals, abandoned buildings, and bank-dens dug by beavers.

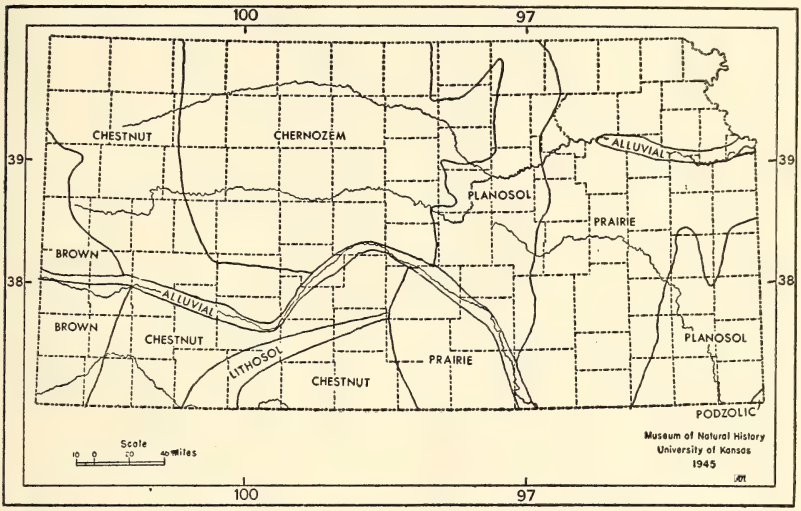

Fig. 2. Soil Types in Kansas (composite drawing from map by the U. S. Dept. Agric. Bur. Chem. and Soils.)

Plum Thicket Farm, the area chosen for study in this western habitat, is three miles north and one mile east of Sharon, Barber County, Kansas. Since 1946, this 640-acre area has been managed for the production of wildlife, by its owner, Mr. Floyd T. Amsden.

Sandy Creek, which runs from north to south, divides the section into two approximately equal halves. On gentle slopes on both sides of the creek there are mixed stands of dogwood, elm, cottonwood and walnut trees. Several of these trees are large and contain suitable den-sites for the raccoon. Dense thickets of buckbrush (*Symphoricarpos orbiculatus*) dominate the understory. Numerous springs and five of the eight man-made ponds on the area drain into Little Sandy Creek within this section of land. Most of the springs issue forth half-way up the slopes and are surrounded by sizable stands of timber. The ponds are fringed with small groves or scattered trees.

The uplands of Plum Thicket Farm contain a diversity of habitats ranging from bare, sandy hillsides to areas densely covered with undisturbed stands of big bluestem (*Andropogon hallii*), four to seven feet tall. The northeast corner formerly was cultivated but now is relatively open although big bluestem is slowly spreading into the area. Large thickets of sand plum (*Prunus angustifolia* var. *Watsoni*) are conspicuous on the uplands. In 1951 the south-central part of the section, comprising approximately 60 acres, was planted

to wheat and sweet clover. Twenty food patches, each less than one acre, at selected places are planted annually to foods for bobwhite quail. These patches, chiefly milo maize (*Sorghum vulgare*) and German millet (*Setaria italica*), are concentrated in the southwest part of the farm. Figure 3 illustrates the vegetation growing on Plum Thicket Farm in 1951.

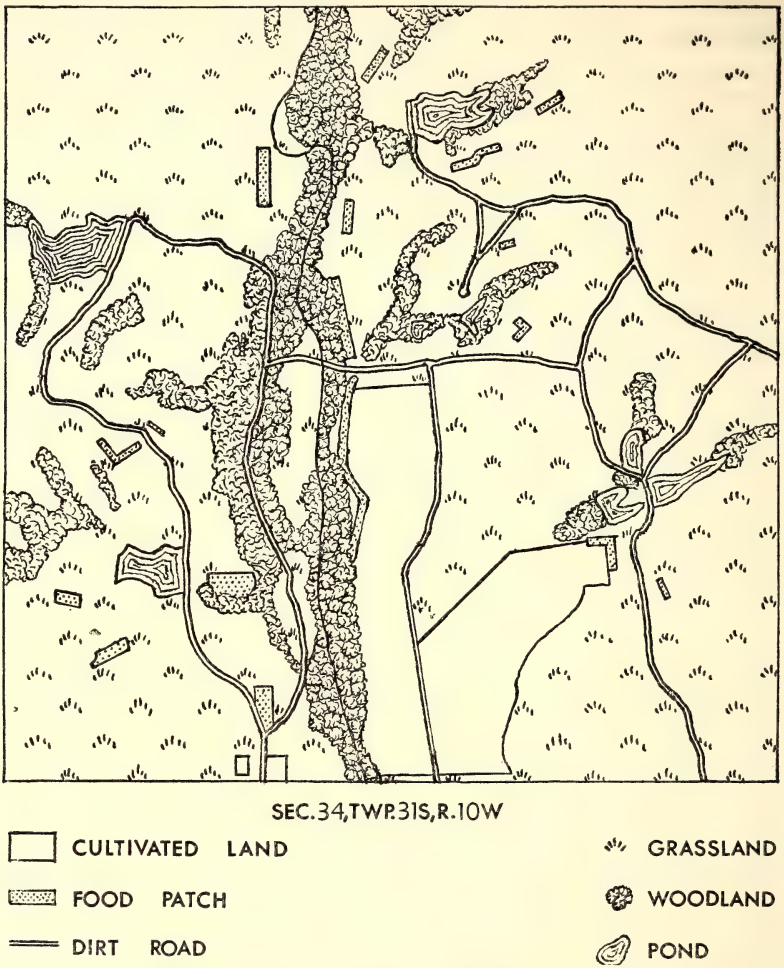

Fig. 3. Vegetation map of Plum Thicket Farm 3 mi. N, 1 mi. E, Sharon, Barber County.

The average annual rainfall in Barber County in 25.5 inches. Little Sandy Creek contains water most of the year but in periods of drouth, flow may be intermittent. Occasional floods of short duration scour the creek-bottom in spring and early summer.

The most important vertebrates competing with raccoons for food in western Kansas probably are ring-necked pheasants (*Phasianus colchicus*), opossums

(*Didelphis marsupialis*), striped skunks (*Mephitis mephitis*), cottontail rabbits (*Sylvilagus floridanus*), fox squirrels (*Sciurus niger*), badgers (*Taxidea taxus*), and deer mice (*Peromyscus maniculatus*).

Habitat in Eastern Kansas

Eastern Kansas is characterized by mixed tall grasses and woodlands, moderate rainfall, numerous permanent streams, and soils of moderate fertility. The major soil-types are planosols and prairie soils (see Fig. 2). The habitat for the raccoon is more favorable in eastern Kansas than in western Kansas, and the species abounds in extensive woodlands bordering streams. Native foods and cultivated plants, chiefly corn, occur in or adjacent to suitable woody cover. In most areas there are dens both in tree-holes and rocky bluffs. Because of widely spaced streamside habitat, the Flint Hills area is less suitable for the raccoon than is the Osage area.

Most field-study in eastern Kansas was done on a farm of approximately 1,100 acres, owned by Dr. F. B. Campbell, three miles southeast of Clinton, Douglas County. The farm consists of two tracts separated by a county road. The northern tract, bordered on the north by the Wakarusa River, is designated by me as the Wakarusa Study Area (Fig. 4). The southern tract, bordered on the southeast by Rock Creek, is designated by me as the Rock Creek Study Area (Fig. 5). The eastern deciduous oak-hickory climax occurs along both the river and the creek and is typical of that found along other streams in eastern Kansas.

The Wakarusa Study Area has a more extensive and wooded bottomland than does the Rock Creek Study Area. The woods are composed of oaks (*Quercus macrocarpa, Q. velutina* and *Q. Muhlenbergii*), hickory (*Carya ovata* and *C. cordiformis*), elm (*Ulmus americana*), cottonwood (*Populus virginiana*) hackberry (*Celtis occidentalis*) and walnut (*Juglans nigra*). The understory was moderately dense, in summer, on the Wakarusa Study Area and consisted mainly of paw paw (*Asimina triloba*), buckbrush (*Symphoricarpos orbiculatus*) and gooseberry (*Ribes missouriense*).

Trees on the Rock Creek Study Area are restricted to the stream bank. Dominant trees are elm, oak, hackberry, cottonwood and box elder. Cultivated fields border the stream on both sides and were planted, at the time of the study, to wheat, corn, sorghum, or alfalfa.

Uplands of both study areas are grazed by cattle. There are a few scattered trees along the rock fences that are numerous on both tracts. A one-fourth acre pond, near the center of the Wakarusa Study Area is used by cattle for drinking. Permanent water otherwise is in the two streams.

The Wakarusa River flows from west to east and is not so well shaded as Rock Creek, which flows northeasterly. The river has the wider stream bed, more gently sloping banks and fewer trees. Owing to little shade, the water becomes warmer and evaporates faster than in Rock Creek, especially when the water is low and not flowing. The Wakarusa River drains a much larger territory than does Rock Creek, and the water level of the River fluctuates

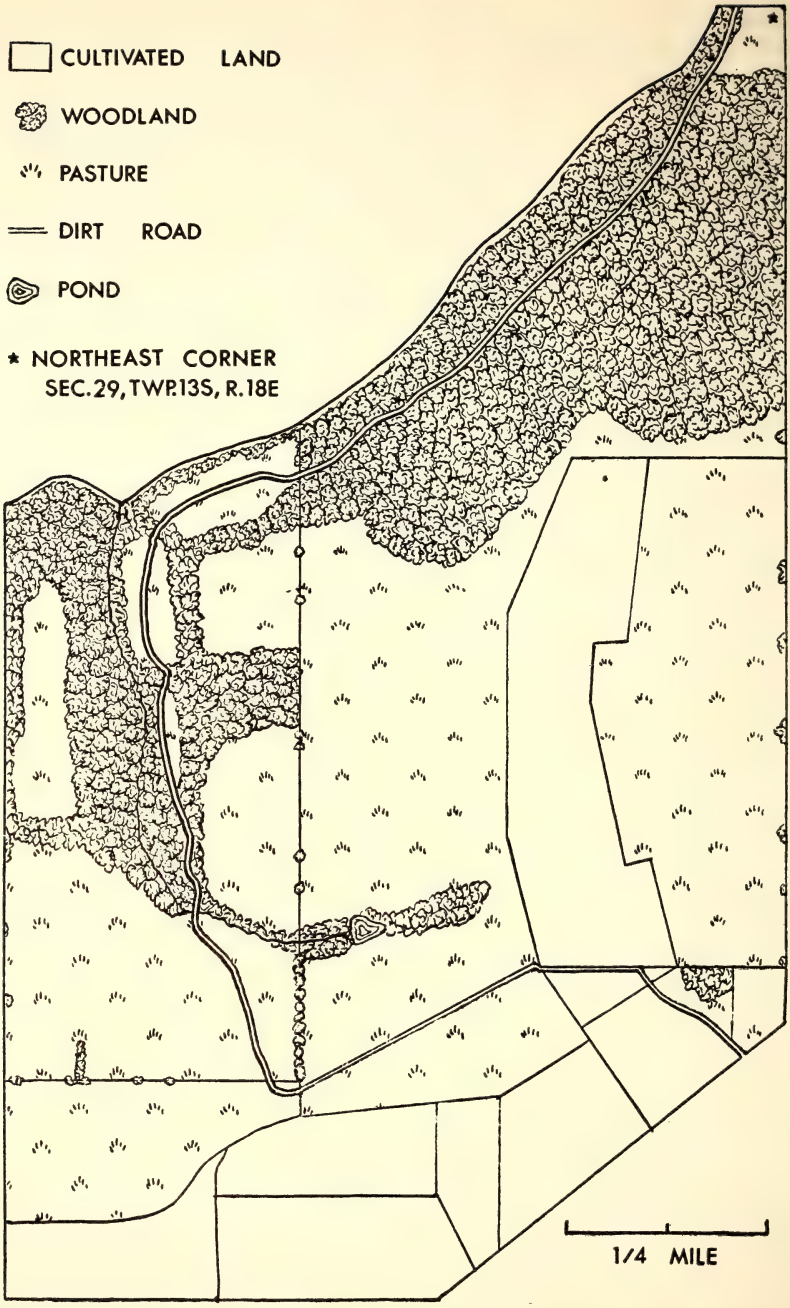

FIG. 4. Vegetation map of the Wakarusa Study Area, Campbell Farm, 3 mi. WSW Clinton, Douglas County.

more in spring and summer. In Rock Creek, root-systems of trees often are undercut and the creek floods several times a year but the water usually does not remain high for more than a few days. Many small pools remain after even weeks of little or no rain.

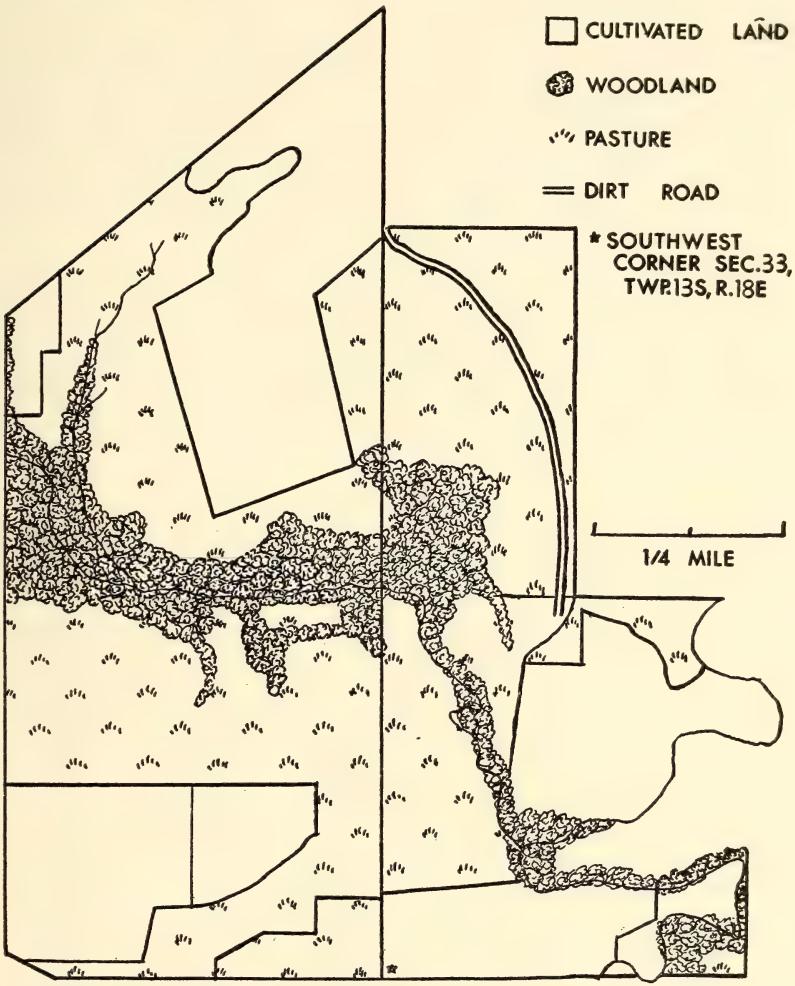

FIG. 5. Vegetation map of the Rock Creek Study Area, Campbell Farm, 3 mi. WSW Clinton, Douglas County.

The Campbell Farm has an abundance of food and shelter for the raccoon. Corn, acorns, mussels, insects, fruits and other foods were abundant in the two years of study. Dens in trees and beneath rock ledges were plentiful. Probably the raccoon uses ground dens to a greater extent than treeholes. Twenty-six potential den trees, inspected several times in two years, were

never occupied by raccoons. Extent of utilization of ground-dens especially in rocky ledges, is often difficult to determine. One yearling female was followed to a ground-den on a rocky hillside (see page 30); on two other occasions, animals were tracked in fresh snow to dens in rocky ledges; another was trailed to a ground-den at the base of a tree; and on several occasions, tracks of raccoons were noted leading from two large brushpiles on the Wakarusa Study Area.

Other furbearers and game mammals living on the Campbell Farm are opossum (*Didelphis marsupialis*), cottontail rabbit (*Sylvilagus floridanus*), gray squirrel (*Sciurus carolinensis*), fox squirrel (*Sciurus niger*), woodchuck (*Marmota monax*), beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), coyote (*Canis latrans*), red fox (*Vulpes fulva*), gray fox (*Urocyon cinereoargenteus*), mink (*Mustela vison*), striped skunk (*Mephitis mephitis*), and spotted skunk (*Spilogale putorius*). The most abundant raptors are red-tailed hawks (*Buteo jamaicensis*), great horned owls (*Bubo virginianus*), and barred owls (*Strix varia*). Vertebrates probably competing with the raccoon for plant foods on the Campbell Farm are opossum, cottontails rabbit, fox squirrel, woods mouse (*Peromyscus leucopus*), red fox, bobwhite quail (*Colinus virginianus*), blue jay (*Cyanocitta cristata*), tufted titmouse (*Parus bicolor*), cardinal (*Richmondena cardinalis*), and red-eyed towhee (*Pipilo erythrophthalmus*). For animal foods, the opossum, muskrat, red fox, mink and striped skunk probably compete with the raccoon.

TABLE 7.

Number of raccoon pelts sold to Kansas fur-dealers and average number of pelts sold per trapping license purchased.

Year	No. Pelts	Av. No. Pelts Sold per License	Year	No. Pelts	Av. No. Pelts Sold per License
1928	5,789	.33	1942	16,774	1.63
1929	24,447	.87	1943	15,666	1.05
1930	22,666	.91	1944	16,899	1.53
1931	21,742	1.46	1945	13,224	1.00
1932	18,698	2.32	1946	36,309	2.50
1933	18,000	1.75	1947	44,259	5.10
1934	17,350	1.77	1948	58,980	7.54
1938	9,375	.95	1949	62,002	8.61
1939	8,374	.60	1951	86,361	10.22
1940	9,744	.90	1952	45,880	7.36
1941	11,215	.82	1953	32,371	8.05

Distribution and Density

By clearing timber, by overhunting, and by causing streams to be silted up, white man discouraged the raccoon in many areas. It persisted in second-growth timber and new plantings. Through regulation of hunting and trapping it increased. The raccoon is something of an opportunist; it found corn and other cultivated foods to its liking, and multiplied in places where these crops were planted. As a result, there is a higher population of raccoons in Kansas today than at the time of settlement. For the raccoon, at least, changes wrought by modern man in Kansas have been favorable to the animal's continued existence there.

Table 8.

Opinions of hunters as to the years of highest raccoon populations in their areas of hunting in Kansas.

Year of Highest Population	Number of Years Hunted							Total Hunters
	2	3	4	5	6–10	11–20	Over 20	
1952	7	11	7	5	36	44	92	202
1951	5	4	7	6	15	36	64	137
1950	.....	4	4	4	16	27	52	107
1949	.....	.....	1	2	5	11	23	42
1948	.....	.....	.....	1	3	5	14	23
1947	.....	.....	.....	.....	4	1	14	19
1946	.....	.....	.....	.....	0	2	6	8
1945	.....	.....	.....	.....	0	0	8	8
1944	.....	.....	.....	.....	0	0	3	3
1943	.....	.....	.....	.....	0	1	6	7
1942	.....	.....	.....	.....	.....	0	2	2
1941	.....	.....	.....	.....	.....	0	2	2
1940	.....	.....	.....	.....	.....	1	2	3
1939	.....	.....	.....	.....	.....	0	1	1
1938	.....	.....	.....	.....	.....	1	0	1
1937	.....	.....	.....	.....	.....	0	0	0
1936	.....	.....	.....	.....	.....	0	2	2

Trapping and hunting have fluctuated annually. As shown in Table 7 a high yield of pelts was taken from 1929 through 1931, whereas a much higher number of pelts was marketed from 1946 at least through 1953. Most raccoon hunters interviewed were of the opinion that the population reached an all-time peak in 1951-52 (see Table 8). This increase in recent years has been reported also in other states in the central and eastern parts of the United States

TABLE 9.

Introductions of raccoons in Kansas in 1934-1953, as reported by hunters.

Area Where Released	Sources of Raccoons Introduced							Total
	Texas	Florida	Minnesota	Oklahoma	California	Wisconsin	Other* States	
Southeast**	683	380	90	62	63	60+	108+	1446+
East-Central***	116	.....	66	.....	.....	.....	45+	277+
Northeast****	.....	.....	.....	.....	.....	.....	12	12
South-Central†	85	40	.....	33	.....	?	30+	208+
Central††	.....	56	20+	.....	.....	.....	10	86+
Southwestern†††	.....	.....	.....	.....	.....	.....	10	10
Total	884	476	176+	95	63	60+	215+	2039+

* Iowa, Neb., Ill., Mich., Ark., Tenn., Mo.
** Neosho, Bourbon, Crawford, Cowley, Elk, Labette, Montgomery, and Butler counties.
*** Johnson, Douglas, Geary, Franklin, Anderson, and Miami counties.
**** Doniphan and Leavenworth counties.
† Harvey, Sumner, Reno, Harper, Barber, and Comanche counties.
†† McPherson, Lincoln, Rice, and Ellsworth counties.
††† Hodgeman County.

(see Sanderson for Missouri, 1951a, and for Iowa, 1951b). In Kansas, at least, hunting and trapping of raccoons declined in 1952-53. Perhaps an epizootic in 1952-53 (see page 39) was partly responsible for the decline in numbers.

Probably a chief reason for the increase of raccoons beginning in 1947 was the small harvest of animals taken in Kansas beginning in 1938. Low prices may have been partly responsible for these small harvests. The war-years of 1941 through 1945 also con-

tributed because of gasoline rationing which limited distances hunters could travel; the absence of many experienced hunters and trappers who were in the service or in defense work; and the preference of the trappers for catching more profitable species, such as mink and muskrat, allowed the raccoon population to increase. Following the war the number of persons who hunted and trapped increased rapidly to an all-time high in 1951-52.

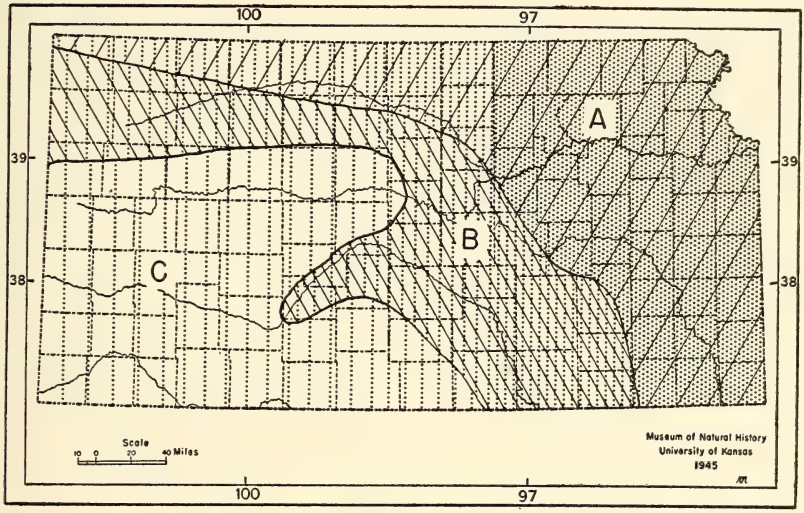

Fig. 6. Relationship of the distribution of raccoons to the principal corn-producing areas of Kansas. A. is the area where most corn is produced, B. moderate production, and C. little or no corn produced. Dots represent density of raccoon distribution in Kansas.

Raccoon hunting clubs, mostly formed in the past 15 years, liberated raccoons brought from other places. Approximately 2000 out-of-state raccoons have been liberated in Kansas since 1939, according to hunters interviewed (see Table 9). At least 719 Kansas raccoons are reported to have been captured and liberated at some other place within the state. Whether liberations on the scale (approximately 125 raccoons per year from 1939 to 1947) could bolster the local population in any part of Kansas is problematical. There is no reason to believe that introduced raccoons could not survive and reproduce in Kansas. Native raccoons, which are more numerous and better adapted to local situations, are more likely to have been responsible for the postwar increase. These introductions may have played a part in the outbreak of histoplasmosis in the population in 1952-53; the introduced animals may

have been more susceptible to the disease organism or hybrid animals may have reduced the natural immunity of the local population.

The largest populations in Kansas are in the best corn producing areas of the state (see Fig. 6). Corn is a favored food and tends to concentrate the animals. Even in marginal habitat in western Kansas, raccoons are much more abundant in the corn-producing parts of the northwest (area "A") than in the southwest (area "C") where principally grain sorghums are grown. Corn left in the fields by mechanical corn pickers or purposely (in 1951 approximately 350,000 acres planted to corn were unharvested, according to Pallesen, 1952:12-13) provide much food in winter, spring and even summer for raccoons and other wildlife. In addition, the more abundant rainfall and permanence of streams (see page 18) may in turn be the initial cause of the larger corn acreages and raccoon populations in area "A" as compared to "B" or "C."

In summary, the raccoon has adapted itself to land occupied by modern man, and corn has become a chief food and is now more abundant than native foods were. Even though there has been an increase in the number of trappers, and especially hunters with dogs, the raccoon has increased. Disease and introductions affect local populations.

Reproduction

Breeding

In Kansas, matings occur from December to June. The height of the mating season is in late February as was indicated when the number of raccoon tracks counted daily increased abruptly on the Wakarusa Study Area beginning on February 11, reached a peak on February 22 and declined gradually until March 15. Four litters examined in late April and May were estimated as having been conceived in late February or early March. Six of 364 females, taken in December and January by hunters, were in oestrous: One on December 26, one on January 14, one on January 21 and three in late January. A female examined by me was in oestrous in late January. Most investigators have found that at least 50 per cent of the females produced litters the first year (Stuewer, 1943:212). Some observers report that first-year males breed, but extensive study, notably that of Sanderson (1951a:450) in Missouri, reveals that they normally do not breed in the first year.

A pair of copulating raccoons was observed on February 26, 1954, at the Campbell Farm from 9:05 a. m. to 10:01 a. m. The morning was cloudy (five-tenths of sky covered), chilly (estimated to be between 35° and 40° F.), and with a breeze of approximately 15 miles per hour. A young female weighing approximately 10 pounds, and an older male weighing approximately 15 pounds, were in a small open grove of saplings on the south bank of the Wakarusa River.

Shrill cries uttered by the female were heard first at 9:05 a. m.; the animals were seen first at 9:09 a. m. when the male, mounted on the female, was tightly holding her in a semi-crouched position with his forelegs immediately in front of her hind legs, and his hind feet were on the ground between hers. He was making rhythmic copulatory movements, consisting of a slower inward motion (requiring three or four seconds) in which he seemed to thrust his penis deeply into the female's vagina, and a faster outward motion (less than one second) as the penis was withdrawn partway and at which time the male's pelvis was elevated and the forepart of his body brought forward and downward. The penis is inserted in the vagina in such a way that the baculum is hooked over the pelvic bone of the female, probably assuring his position on the female (Whitney and Underwood, 1952a:9). At each of the quick withdrawing motions the female uttered a sharp rattling cry and often attempted to bite the male by turning her head upward. Her actions frequently caused the pair to lose their footing and fall, the male always holding his position.

At 9:17, the male ceased the thrusting movements, and at 9:19 he began jerking movements, from one side to the other, roughly pulling the hindquarters of the female with him, causing her to utter a short cry. This activity caused the pair to move in a circle with heads toward its center. The vigorous thrusting movements were resumed at 9:29, and at 9:42, the cries of the female diminished except for an occasional whimper. Copulatory movements ceased at 9:46, at which time the pair settled slowly to the ground. The forepart of the male was down with his head over the left side of the female and his hindquarters conspicuously high. Less than two minutes later, the male again was dragging the female in a space approximately ten feet in diameter. At 9:51 thrusting movements, slower than those previously noted, were resumed. The rate of these movements was soon doubled but this time the withdrawing motion of the male was less vigorous and the female was not cry-

ing out. These movements were interrupted three times by the male by short circular movements. At 10:01, the male suddenly slipped away from the female and ran rapidly southward. The female hesitated a few seconds then, slowly walked eastward, and entered a ground den.

Litters

In Kansas, most litters probably are born in late April and early May. A litter found on April 27, 1954, was estimated to be two or three days old; one found on May 22, 1954, was estimated to be one week old; one found on May 26, 1953, was not seen but the young were heard in a hollow tree; one found on May 29, 1953, was estimated to be three weeks old; and one found on June 2, 1952, was estimated to be five weeks old.

Raccoons in Kansas produce only one litter yearly. Bissonnette and Csech (1938:345), by controlling the light, induced the production of two litters in one year in four captive females. On fur farms, breeders of raccoons have obtained two litters each year per female by weaning the young at an early age. If the first mating is unsuccessful, a second mating, two to four months later, may occur and produce a late litter (Whitney and Underwood, 1952a: 82). A late litter of four found on October 5, 1954, in Anderson County, was judged to have been conceived in June.

Eight litters (averaging 4.6 young), observed in Kansas, contained: five young (not sexed) in Anderson County in mid-April, five young (four males, one female) in Anderson County on April 27, four young (three males, one female) in Anderson County on May 22, four young (one male, three females) in Anderson County on May 29, five young (not sexed) in Saline County on June 2, seven young (four males, three females) in Rawlins County on June 11, three young (not sexed) in Miami County on August 17, and four young (one male, one female, two not sexed) in Anderson County on October 5. Three litters were in tree cavities from 9 to 35 feet above ground: two were in elms and one was in a shagbark hickory (see Pl. 2). Another litter was seen sunning in an elm tree that contained a hollow, another was found in a hen house, another was in an abandoned school, and two were in the open.

Raccoon hunters reported that on 96 hunts, in October, 37 family groups (including one or more adults) were treed (2 to 7 raccoons, averaging 4.3 raccoons per group); in November on 141 hunts, 18 family groups were treed (2 to 6 raccoons, averaging 2.9); in December on 177 hunts, 17 family groups were treed (2 to 6 raccoons, averaging 2.7); in January on 95 hunts, 4 family

groups were treed (2 to 3 raccoons, averaging 2.5). In October, 54 per cent of all raccoons taken by hunters were in family groups; in November, 17 per cent; in December, 15 per cent; and in January, 9 per cent. The decreasing number of family groups present after October indicates that young are separated from their parents soon after the beginning of the hunting season.

Sex Ratio

Adult male raccoons may slightly outnumber adult females in natural populations. A ratio of 1.5 males per female was reported for 918 raccoons taken by Kansas hunters and for raccoons examined at a fur-establishment in Lawrence. In Missouri, Noren (1941b:20) obtained a similar ratio in hunter-taken animals, and Sanderson (1951a:450), also in Missouri, recorded equal numbers of both sexes. At birth the sex ratio is approximately one to one as shown by counts of litters. Some hunters free females treed by dogs, but this practice is not widespread (see Noren, *loc. cit.*). More than likely, males have greater mobility; consequently, their trails are more easily detected by dogs with the result that more males than females are taken. Even if there are more males than females in autumn, the breeding population contains fewer males because fewer first-year males are able to mate than are first-year females. Of raccoons taken by Kansas hunters, the age and sex of 624 was recorded. Of these, 39 per cent were females (both adults and first-year animals) and 34 per cent were adult males and presumed capable of breeding—a sex ratio of .87 male per female. Assuming that only 50 per cent of the first-year females breed, the sex ratio of the breeding population was approximately equal—1.1 males per female.

Development of Young

Several authors have investigated growth of young raccoons. Llewellyn (1953:320-321) measured embryos of known ages. According to Stuewer (1943:214) three animals in Michigan weighed an average of 61.7 grams at birth and gained approximately 500 grams in the first month of life, 400 grams the second month, and 1000 grams each month from the third through the seventh month after birth. Three animals, judged by me to be approximately one week old, possessed distinct bands on their tails (see *a*, Pl. 1). In a litter that he had under observation, Hamilton (1936:136) observed these annulations first when the raccoons were 19 days old. The eyes of young raccoons open between 19 and 24 days of age (Whitney and Underwood, 1952a:87). When two months old, young are agile; at three months they venture out of the den and climb about; and at four months the young are weaned and follow the parent from the den in search of food.

Coalescense of Bones of Skull

Sutures still are open between most bones of the skull of young of the year taken in December and January. Examination of 79 skulls from Kansas indicates that the usual order of ankylosis of bones of the skull is: Between basioccipital, exoccipitals and supraoccipital; between frontal bones; between frontals and parietals; between parietals; between maxillaries and premaxillaries; between basisphenoid and basioccipital; ankylosis of interparietal with parietals and supraoccipital; between maxillaries and frontals; between frontals and nasals; between nasals and premaxillaries; and between nasals.

Teeth

Hamilton (*loc. cit.*) found that no teeth had appeared in animals one week old; but at nineteen days the canines and lower incisors on both jaws had

TABLE 10.

Order in which permanent teeth erupted in five skulls of raccoons from Kansas and Nebraska. Skulls arranged from youngest to oldest.

Cat. No.	Sex	Date Taken	Incisors	Canines	Premolars	Molars
KU 1572 & 1573	M	Sept. 16	000–000 / 000–000	0–0 / 0–0	1000–1000 / 1000–1000	00–00 / 00–00
KU 14179	F	June 10	110–110 / 110–110	0–0 / 0–0	1000–1000 / 1000–1000	00–00 / 00–00
KU 37327	M	July 27	111–111 / 111–111	0–0 / 0–0	1000–1000 / 1000–1000	10–10 / 10–10
KU Zool. 344	M	Oct. 13	111–111 / 111–111	0–0 / 0–0	1000–1000 / 1000–1000	11–11 / 11–11

TABLE 11.

Order in which deciduous teeth were lost in six skulls of raccoons from Kansas and Nebraska. Skulls arranged from youngest to oldest.

Cat. No.	Sex	Date Taken	Incisors	Canines	Premolars
KU 1572 & 1573	M	Sept. 16	011–011 / 011–011	1–1 / 1–1	0111–0111 / 0111–0111
KU 14179	F	June 10	011–011 / 011–011	1–1 / 1–1	0111–0111 / 0111–0111
KU 37327	M	July 27	001–001 / 00?–00?	1–1 / 1–1	0111–0111 / 0111–0111
KU Zool. 344	M	Oct. 13	000–000 / 000–000	1–1 / 1–1	0111–0111 / 0111–0111
KU 6651	M	Dec.	000–000 / 000–000	1–1 / 0–0	0100–0100 / 0000–0000

erupted and the upper incisors were barely perceptable as knobs; and at thirty days the upper incisors had erupted. Permanent teeth replace deciduous teeth when animals are from 16 to 20 weeks of age (Stuewer, *op. cit.*:213). Thirteen skulls of young raccoons from various localities, in the collection of the Museum of Natural History, University of Kansas, lack complete permanent dentitions. These skulls demonstrate the order of eruption of permanent teeth and the order in which deciduous teeth are lost (see Tables 10 and 11).

The second deciduous incisors, in both jaws, are tiny peglike structures, less than one-fifth as large as the spade-shaped third deciduous incisors. The second upper and lower deciduous premolars are narrower and smaller but otherwise are similar to the second permanent premolars (see Fig. 7). In occlusal view, the third upper deciduous premolars are triangular and each possesses three roots, whereas, the third upper permanent premolars are oval and each possesses two roots. The third lower deciduous premolars are rectangular, whereas, the permanent replacements of these are oval. The fourth upper deciduous premolars are triangular, whereas, the fourth upper permanent premolars are square. The cusps on each of the fourth lower deciduous premolars are approximately the same height, whereas, the paraconid on the fourth lower permanent premolar is much higher than other cusps on this tooth. The fourth lower deciduous premolars closely resemble the first lower molars but are smaller. Figure 7 depicts the deciduous and the permanent dentitions.

Methods of Aging Raccoons

Body-weight (see Sanderson, 1950:396), body-size, size and coloration of teats (see Stuewer, 1943:217 and Sanderson, *op. cit.*:397), size and weight of baculum (see Sanderson, *op. cit.*:391-396), tooth-wear (see Wood, 1952:48), and size of canines (see Stuewer, *op. cit.*:216) have been used as means of aging raccoons. These methods reveal whether an animal is a young of the year or is fully adult but do not distinguish all animals in their second year from those that are older. Raccoons are not considered as fully adult until at least three years old.

Two additional methods of aging raccoons, investigated by me, are the degree of ankylosis of bones of the skull (see page 31) and the ratio of the postorbital breadth to the interorbital breadth of the skull. Most young of the year can be separated from most older animals by the ratio of the postorbital breadth to the interorbital breadth. In most young raccoons the postorbital region is broader than the interorbital region, whereas, in most older animals the reverse is true (see Fig. 8). When more specimens of known age are available, I believe that by using a combination of these two methods the skulls of each of the three age-classes (first-year animals, second-year animals and adults) can be recognized.

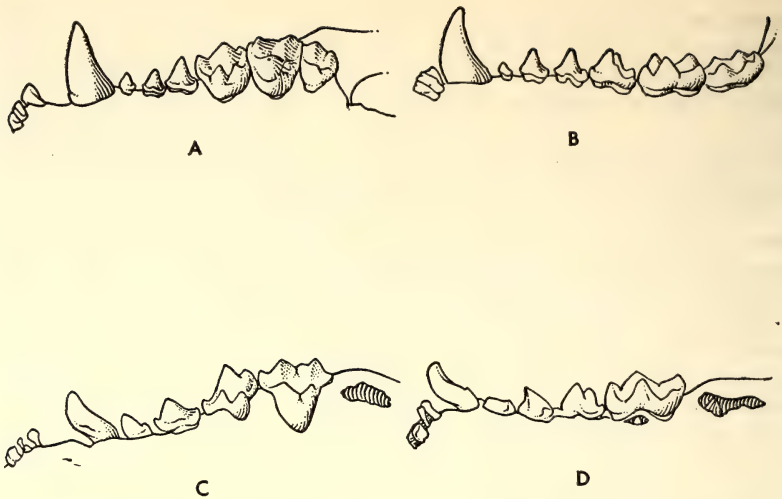

FIG. 7. Dentition in *Procyon lotor hirtus* Nelson and Goldman. Occluso-lingual views of A. upper permanent teeth, yearling female, Cat. No. 4284 KU, B. lower permanent teeth of No. 4284 KU, C. upper deciduous teeth juvenal female, Cat. No. 14179 KU, and D. lower deciduous teeth of No. 14179 KU. (Drawings by Victor H. Hogg.)

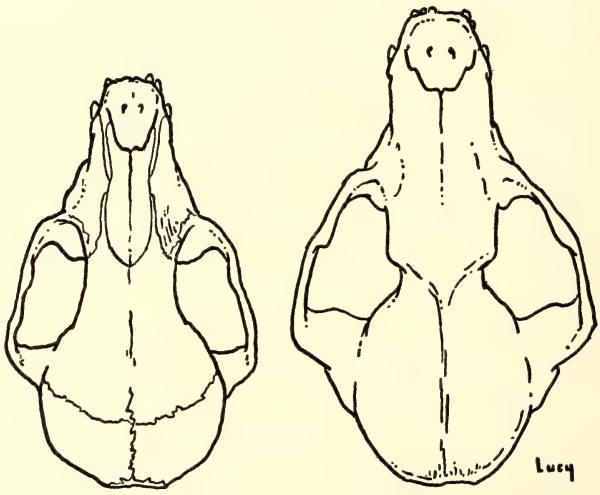

FIG. 8. Difference between postorbital and interorbital breadths in (A) a raccoon less than one year old, Female, 3 October 1949, ½ mi. S, 1 mi. W Lawrence, Douglas County, Cat. No. Zool. 343 KU, and (B) a raccoon three or more years old, Male, March, 1943, Meade State Park, Meade County, Cat. No. 35032 KU. (Traced from Photo by Donald W. Janes.)

Predators, Parasites and Disease

Predators

In Kansas there is no animal that seems to prey extensively on raccoons. The bobcat (*Lynx rufus*), red fox (*Vulpes fulva*), coyote (*Canis latrans*), and certain owls are reported in literature to prey on raccoons. Probably the bobcat, which occurs in small numbers, especially in southern Kansas, is of minor importance as a predator. Remains of raccoons have been found in feces of red foxes in Iowa (Scott, 1947:474). The red fox, common in eastern Kansas, could prey on young raccoons; Whitney and Underwood (1952a:93) report an unsuccessful attempt by a red fox to capture a young raccoon defended by its mother.

In Kansas, coyotes and large owls probably feed on raccoons more frequently than do other animals. Remains of raccoons have been found in nests, stomachs and pellets of unidentified owls (Whitney and Underwood, *op. cit.*:92). Two of 118 coyote scats that Fitch and Packard (1955:212) examined from the University of Kansas Natural History Reservation contained hair of raccoons. Sperry (1941:46) reported flesh and fur of raccoon in the stomach of one coyote and writes that "Such food might well be classified as accidental, for the typical habitat of raccoons would tend to keep them out of the coyotes' way." In western Kansas, a plains area, raccoons occasionally travel considerable distances across open lands between surface waters, and have no opportunity to escape from coyotes by climbing trees. In eastern Kansas, coyotes have some opportunity to prey on raccoons in winter because both raccoons and coyotes forage to a great extent at that season along wooded streamways. No evidence of predation on raccoons was found in 2500 scats and 747 stomachs of coyotes examined in Nebraska (Fichter, Schildman and Sather, 1955).

Parasites

Published records on ectoparasites and endoparasites of the raccoon are summarized in Tables 12 and 13, respectively.

Ticks (*Dermacentor variabilis*) often are on raccoons in summer in Kansas. On a young female, captured in a live-trap at the University of Kansas Natural History Reservation, on May 14, 1954, these ticks were concentrated on the ears, neck, and bends of the limbs. Of 820 raccoon scats examined, only nine (of the 159 found in late spring and summer) contained ticks. Fleas, identified as *Pulex irritans* by Earl Cross of the Department of Entomology, University of Kansas, were collected from a raccoon taken on December 5, 1953, in south-central Kansas on the Plum Thicket Farm in Barber County.

Ascarids (*Ascaris* sp.) are in the small intestine of many raccoons; these worms fill the lumen of the small intestine of some individuals. Eight of 33 stomachs and of 820 scats examined contained from one to 16 small ascarids; the longest was 35 mm.

TABLE 12.

Ectoparasites of *Procyon lotor* as reported in the literature.

Parasite	Reference
Fleas (Siphonaptera)	
Cediopsylla simplex	Morlan, 1952.
Ctenocephalides felis	Morlan, 1952; Kellner, 1953.
Ctenocephalides canis	Stiles and Baker, 1935.
Xenopsylla cheopis	Morlan, 1952.
Orchopeas howardi	Morlan, 1952; Wood, 1952.
Polygens gwyni	Morlan, 1952.
Echidnophaga gallinacea	Eads, 1948.
Trichopsylla lotoris	Steward, 1926; Morgan and Waller, 1940; Stuewer, 1943.
Ceratophyllus wickhami	Stiles and Baker, 1935.
Pulex irritans	Stiles and Baker, 1935; Wood, 1952.
Sucking lice (Anoplura)	
Polyplax spinulosa	Morlan, 1952.
Chewing lice (Mallophaga)	
Suricatoecus octomaculatus	Stuewer, 1943; Morlan, 1952.
Trichodectes crassus	Stiles and Baker, 1935; Morgan and Waller, 1940.
Trichodectes melis	Stiles and Baker, 1935.
Trichodectes octomaculatus	Stiles and Baker, 1935; Johnson, 1939.
Trichodectes procyonis	Stiles and Baker, 1935.
Neotrichodectes mephitidis	Wood, 1952.
Mites and ticks (Acarina)	
Haemolaelaps glasgowi	Morlan, 1952.
Bdelonyssus bacoti	Morlan, 1952.
Ixodes sp.	Stuewer, 1943; Morlan, 1952; Wood, 1952.
Ixodes cookei	Stiles and Baker, 1935; Morgan and Waller, 1940; Morlan, 1952; Wood, 1952.
Ixodes diversifossus	Stiles and Baker, 1935.
Ixodes marxi	Stiles and Baker, 1935.
Ixodes ozarkus	Cooley, 1944.
Ixodes scapularis	Morlan, 1952.
Ixodes texanus	Stiles and Baker, 1935; Morlan, 1952; Wood, 1952.
Amblyomma americanum	Morlan, 1952; Wood, 1952.
Dermacentor variabilis	Stiles and Baker, 1935; Morlan, 1952.
Trombicula cynos	Wharton and Fuller, 1952.
Trombicula alfreddigesi	Wharton and Fuller, 1952.
Trombicula splendens	Wharton and Fuller, 1952.
Trombicula multisetosa	Wharton and Fuller, 1952.

TABLE 13.

Endoparasites of *Procyon lotor* as reported in the literature.

Parasite	Reference
Protozoan	
Eimeria nutalli	Yakimoff and Matikaschwili, 1933; Morgan and Waller, 1940.
Babesia sp.	Stiles and Baker, 1935.
Trypanosoma hippicum	Stiles and Baker, 1935.
Trypanosoma gambiense	Stiles and Baker, 1935.
Flatworms (Platyhelminthes)	
Pharyngostomoides ovalis	Chandler and Rausch, 1946.
Pharyngostomoides procyonis	Harkema, 1942; Chandler, 1942b.
Fibricola cratera	Morgan and Waller, 1940.
Fibricola laruei	Miller, 1940.
Fibricola texensis	Chandler, 1942ab.
Eurytrema procyonis	Denton, 1942; Chandler, 1942b.
Agamodistomus la-ruei	Hughes, 1928.
Metagominoides oregonensis	Price, 1931.
Heterobilharzia americana	Price, 1943.
Microphallus sp.	Rausch, 1946.
Opophallus venustus	Kellner, 1953.
Clinostomum sp.	Stuewer, 1943.
Traglotrema salmincola	Kellner, 1953.
Nonophyetus salmincola	Stiles and Baker, 1935.
Oochoristica sp.	Johnson, 1939; Leigh, 1940.
Oochoristica procyonis	Chandler, 1942b.
Mesocestoides sp.	Morgan and Waller, 1940; Ingram, 1941; Stuewer, 1943.
Mesocestoides lineatus	Coatney, 1936; Johnson, 1939.
Mesocestoides variabilis	Chandler, 1942b.
Diphyllobothrium sp.	Stuewer, 1943.
Diphyllobothrium caninum	Kellner, 1953.
Diphyllobothrium latum	Stiles and Baker, 1935; Whitney and Underwood, 1952a.
Taenia pisaformis	Whitney and Underwood, 1952a.
Prostenorchis ingens	Stiles and Baker, 1935.
Prostenorchis spirula	Stiles and Baker, 1935.
Roundworms (Nematoda)	
Ascaris sp.	Leigh, 1940; Tiner, 1953; Kellner, 1953.
Ascaris columnaris	Morgan and Waller, 1940; Rausch, 1946; Waller, 1940; McNeil and Krogsdale, 1953.
Ascaris procyonis	Stefanski and Zarnowski, 1951.
Arthrocephalus sp.	Leigh, 1940.
Arthrocephalus (Uncinaria) lotoris	Schwartz, 1925; Chandler, 1942b; Stuewer, 1943; McNeil and Krogsdale, 1953.
Molineus barbatus	Chandler, 1942b.
Physaloptera sp.	Law and Kennedy, 1932; Johnson, 1939; Morgan and Waller, 1940; Kellner, 1953.
Physaloptera maxillaris	Ingram, 1941.
Physaloptera praeputialis	Kellner, 1953.
Physaloptera rara	Rausch, 1946.
Physaloptera turgida	Leigh, 1940.
Gnathostoma procyonis	Chandler, 1942b.
Dracunculus (Filaria) insignis	Leidy, 1858; Chandler, 1942bc; Siegler, 1946; Cheatum and Cook, 1948.

TABLE 13.—*Concluded.*

Parasite	Reference
Roundworms (Nematoda) (Conc.)	
Synhimantus longigutturata	Chandler, 1942b.
Crenosoma sp.	Goble and Cook, 1942.
Crenosoma goblei	Dougherty, 1945.
Tetragomphius procyonis	Johnson, 1939.
Ancylostoma caninum	Chitwood, 1933.
Dirofilaria tenuis	Chandler, 1942b.
Filaria immitis	Whitney and Underwood, 1952a.
Trichuris vulpis	Whitney and Underwood, 1952a.
Capillaria sp.	Law and Kennedy, 1932.
Brachylaemus pellucidum	McNeil and Krogsdale, 1953.
Porracaecum decifens	McNeil and Krogsdale, 1953.
Dioctophyme gigas	Stiles and Baker, 1935.
Dioctophyme renale	Kellner, 1953.
Trichinella spiralis	Stiles and Baker, 1935.
Toxascaris canis	Kellner, 1953.
Microcephalus sp.	Kellner, 1953.
Skrjabingylus nasicola	Kellner, 1953.
Gordacia sp.	Kellner, 1953.
Spiny-headed worms (Acanthocephala)	
Macracanthorhynchus hirundinaceus	Stiles and Baker, 1935.
Macracanthorhynchus ingens	Chandler, 1942b; Moore, 1946; Kellner, 1953.
Echinorhynchus gadi	McNeil and Krogsdale, 1953.

Small unidentified filarialike nematodes were under the skin of an adult male raccoon trapped in Trego County on January 27, 1954. This raccoon had poor pelage, no tail and numerous ulcers on the back and shoulders, but seemed normal internally, according to Dr. Edwin P. Martin of Fort Hays State College (*in litt.*). Fragments of tapeworms were in each of 18 raccoon scats, and four cestodes were in one stomach.

Diseases

Diseases, mostly reported in raccoons on fur-farms, include feline laryngitis and enteritis (Seifried and Krembs, 1940), gastroenteritis (Waller, 1940), fox encephalitis (Green, Evans and Nanamura, 1943), dog and cat distemper (Goss, 1948), tuberculosis (Brown, 1931), pseudotuberculosis (Green and Shillinger, 1936), purulent fibrinous pleuritis and pericarditis (Zschokke and Saxer, 1932), listeriosis (Gifford and Jungherr, 1947), shock disease (Christian and Ratcliffe, 1952) and rabies (Whitney and Underwood, 1952a; Wood, 1954).

A disease called either distemper or encephalitis by many hunters was reported in raccoons in several counties in eastern Kansas from November, 1952, through March, 1953. Sick raccoons lacked energy, were unaggressive, and had swollen eyes and diarrhea. Five raccoons, three of them alive, were obtained by me for laboratory examinations by Drs. Robert W. Menges of the

U. S. Public Health Service and Robert T. Habermann of the National Institute of Arthritis and Metabolic Diseases. The etiology of the distemperlike disease was suggestive of a virus, and demonstration of inclusion bodies in tissues supported this hypothesis (see Menges, Habermann and Stains, 1955).

Two fungal organisms, previously unreported from raccoons, were present in the four sick animals examined. *Histoplasma capsulatum,* responsible for the disease histoplasmosis, was isolated from the spleen, liver and axillary lymph glands of the four raccoons. *Haplosporangium parvum,* the causitive agent of haplomycosus, was found in the lungs of two of the sick animals. *Histoplasma capsulatum* occurs in epidemics in man (Grayston and Furcolow, 1953) and in epizootics in dogs (Robinson, McVickar and Peterson, 1951) and probably could cause epizootics in raccoons. *Haplosporangium parvum* probably does not cause epizootics. In addition, three of the four sick raccoons were heavily parasitized by ascarids.

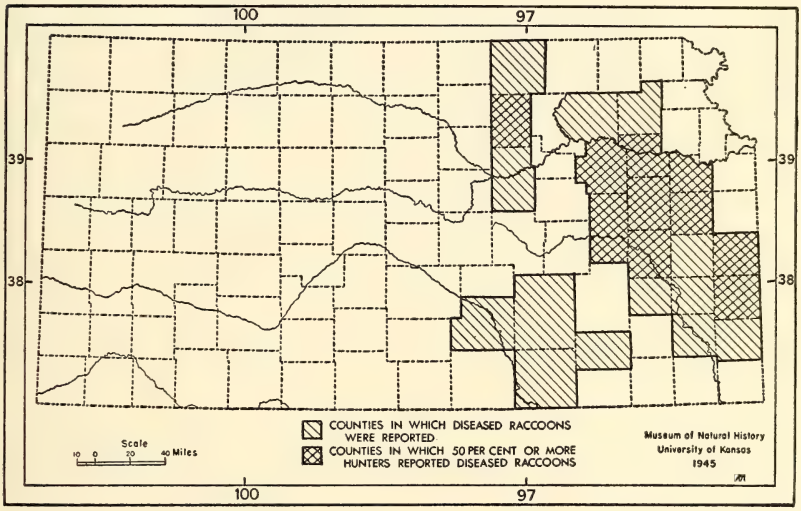

Fig. 9. Distribution of epizootic in the raccoon population in 1952-53.

Hunters reported sick raccoons, having symptoms suggestive of this disease, from 23 counties in 1952-53 (see Fig. 9) but from only 6 counties in 1953-54. Perhaps this virus and associated organisms were, at least in part, responsible for the decline of the raccoon population in 1953-54 in eastern Kansas.

Feeding Habits and Food

Raccoons forage mostly at night. They eat animal and plant materials. The foods eaten depend on locality and seasonal availability (see Tables 17 and 18). Food habits of raccoons have been studied in Texas (Baker, Newman and Wilke, 1945), Iowa (Cabalka, 1952; Costa, 1951; Giles, 1939), Michigan (Dearborn, 1932), Pennsylvania (Grimm and Roberts, 1950), New York (Hamilton, 1936 and 1940), Maine (Johnson, 1939), Virginia (Kellner, 1953), Maryland (Llewellyn and Uhler, 1952), Missouri (Noren, 1941a) and Illinois (Yeager and Rennels, 1943).

Methods of Study

Examination of scats, the fecal droppings of animals, provided most of my information on food habits of the raccoon in Kansas. Of 820 scats examined, 705 were from the Campbell Farm in Douglas County and 115 from other counties. Foods in 22 stomachs of winter-taken raccoons were analyzed. Contents of scats and stomachs were examined both qualitatively and quantitatively.

Scats rarely indicate the total volume of food eaten, because usually only hard and undigested parts of food are expelled; soft foods, such as earthworms, caterpillers and flesh of mollusks, are undetectable. Although food particles are expelled within two days after having been eaten (Wood, 1952:66-70), traces of some foods appear in scats as much as five days after having been eaten. Consequently, analyses of scats may be misleading as to the frequency with which some foods are eaten. Use of scats to study food habits is advantageous because animals need not be sacrificed and many seasonal samples of food can be obtained easily.

In late summer, autumn and winter, scats of raccoons usually can be identified more easily than at other seasons because the animals defecate at regularly-used scat-stations; in spring and early summer, most droppings are deposited at random. Scats are usually smooth and cylindrical and either rounded at both ends or pointed at one end; unformed stools often are expelled in late summer and early autumn. A raccoon scat, usually indistinguishable in size from those of the striped skunk, opossum and red fox, measures from 25 to 310 mm. in length (average 120 mm.) and from 6 to 27 mm. in diameter (average 16 mm.). Fifty-two per cent of the scats were between 15 and 18 mm. in diameter. Raccoon scats contain large particles of food more often than do opossum scats, because the raccoon masticates its food less (Wood, 1952:71). Raccoon scats seldom have as strong an odor as scats of canids and skunks. Hair of the raccoon serves to identify some of its scats; 53 per cent of all scats examined contained the animal's hair.

Scats were placed in paper sacks (size No. ½) as collected, and the date, location, description of collecting place, and condition of the scat were marked on the outside of each sack. Stomachs were wrapped in cheesecloth and preserved in 10 per cent formalin. Each scat and stomach was analyzed by means of a binocular microscope and a reference collection of food materials. The amount of each kind of food, figured as a percentage, was calculated by visual means. Results of the analysis of each scat and contents of each stomach, together with collecting data, were written on a 5 x 8 card.

Scat-stations

From the Campbell Farm, 705 scats were obtained by making weekly collections for two years from 14 scat-stations. A scat-station, a place where raccoons often leave fecal deposits, is used principally for loafing or resting. Raccoons expelled more feces at stations 4, 5, 6, and 8 than at other scat-stations. In all, 77 scats were collected from station no. 4, 207 from no. 5, 96 from no. 6, and 135 from no. 8.

Scat-station no. 4 was on a live boxelder (*Acer negundo*), which had three principal trunks. One of these trunks, growing at a 25° angle from the ground and extending over the east bank of Rock Creek, was used for deposi-

PLATE 1

FIG. *a*. Three juvenal raccoons, from a litter of five, judged to be no more than one week old. Notice the distinct annulations of the tail. Taken on May 29, 1954, three miles northwest of Welda on Cedar Creek. × approximately ¼.

FIG. *b*. A litter of four juvenal raccoons from three miles south of Welda, Deer Creek, Anderson County, Kansas. Three are dark "valley coons" and one is a pale "prairie coon." × approximately ¼.

PLATE 2

a.

b.

c.

d.

PLATE 2. Trees in Kansas containing dens in which litters of raccoons were observed.

FIG. *a.* Elm on Deer Creek, 3 mi. S Welda, Anderson County.
FIG. *b.* Shagbark hickory on Cedar Creek, 3 mi. NW Welda, Anderson County.
FIG. *c.* Elm on Cedar Creek, 4 mi. NW Welda, Anderson County.
FIG. *d.* Elm on Little Bull Creek, 9 mi. N Paola, Miami County.

PLATE 3

a.

See the account of scat-stations on pages 40-41 of the accompanying text.

b.

Scat-stations on the Campbell Farm, 3 mi. WSW Clinton, Douglas County.
a. Scat-station No. 5. *b.* Scat-station No. 8.

PLATE 4

Raked-area number 43, across the stream bed of the Wakarusa River, 3 mi. WSW Clinton, Douglas County, showing tracks of a raccoon that had crossed from right to left.

tion of feces. Probably this tree served also for resting; the horizontal view was unobstructed, except for trees, for at least 1000 feet.

Scat-station no. 5 (Pl. 3, fig. *a*) was composed of two parts: A pile of woody debris on the south bank of Rock Creek, and a log-jam forming a platform across the creek and four feet above the water-level. In early June, 1954, this station was removed by flood waters except for one log extending from the north bank of the creek into the water. Station no. 5 was little used by raccoons following the flood, and feces were deposited instead, on a large fallen tree on the north bank of the creek, 40 feet northeast of scat-station no. 5. Visibility to the north, and to the south, was no more than 75 feet since the scat-station was situated below the high banks of Rock Creek; but to the east or west, up or down the creek, visibility was at least 800 feet. This scat-station was used frequently perhaps because it was adjacent to food in a corn field. Also, the log-jam formed one of two "bridges" for raccoons across Rock Creek on the study area.

Scat-station no. 6 was on a platform of debris that had accumulated on two large logs in Rock Creek. This platform, approximately 11 feet above water-level, provided partial visibility for at least 50 feet to the north and at least 600 feet to the east and west.

Scat-station no. 8 (Pl. 3, fig. *b*), was on several large logs and associated debris. These logs formed the second available "bridge" across Rock Creek. Raccoons usually used the largest log, which was seven feet above the water, as a latrine. Visibility was at least 50 feet to the north and south and at least 800 feet to the east and west. This scat-station was removed by flood waters in early June, 1954.

Scat-station nos. 2, 3 and 12, the stations least productive of scats, were on the Wakarusa River. Stations 2 and 3 were on mud flats at the water's edge, and station 12 was on a log felled across a dry gully, approximately 75 feet from the river. Obstructions obscured visibility in most horizontal directions at these scat-stations.

Most scat-stations are on logs, debris or in trees. Visibility at these places usually is unobstructed horizontally for at least 50 feet. In large trees in Anderson County, accumulations of raccoon feces were found as high up as 40 feet above ground.

As shown in Table 14, raccoons used scat-stations chiefly from late July through November; more scats were obtained in October than in any other month. Probably scat-stations are used mostly in late summer and autumn because seasonal foods are concentrated and because raccoons are traveling in family groups. At other times of the year, animals range over a larger area foraging for less concentrated foods and deposit their feces over a wider area.

Vegetable Food

Vegetable foods form the bulk of the raccoon's diet in all seasons (see Tables 16, 17 and 18).

TABLE 14.

Raccoon feces collected from scat-stations per month for two years.

Month	1952–53	1953–54	Average
September	99	39	69
October	118	103	111
November	108	62	85
December	14	9	12
January	5	1	3
February	5	9	7
March	3	7	5
April	3	10	7
May	6	11	9
June	3	2	3
July	...*	22	22
August	...*	55	55

* Scat-stations were not visited by me in July and August, 1953.

Corn (*Zea mays*) is the most important food of the raccoon in Kansas. More than one-half of the scats and stomachs taken in autumn, winter and spring contained corn. Between two to three million acres (4 to 6 per cent of the land area) of corn are planted annually in Kansas (see Fig. 6). As previously stated, most raccoons occur where corn is the principal agricultural crop.

Sorghum (*Sorgum vulgare*) is eaten principally in autumn by raccoons in western Kansas, but in areas where both sorghum and corn grow, corn is the preferred food. Although equal acreages of sorghum and corn were planted on the Campbell Farm, sorghum occurred in small amounts in a few scats and corn occurred in large amounts in most scats.

Acorns (*Quercus* spp.) are eaten at all seasons but mostly in autumn. In areas where little corn is grown, more acorns are eaten than elsewhere. There are few oaks in western Kansas.

Grapes (*Vitis vulpina*) become ripe in late summer and early autumn, and raccoons prefer this fruit to other foods.

Fruit of pokeweed (*Phytolacca americana*) is eaten in quantity in all parts of the State. From late August through November (Gates, 1940:202) this fruit is ripe. Raccoons eat it in August, September and October but not in November.

Seeds of hackberry (*Celtis occidentalis*) appear in scats of raccoons in late summer in eastern Kansas, especially before corn becomes available. In

western Kansas, raccoons travel more than a mile (see page 52) to feed on these berries.

Mulberries (*Morus rubra*), gooseberries (*Ribes* sp.) and cherries (*Prunus* sp.) are important as summer foods in both eastern and western Kansas. Smartweed (*Polygonum lapathifolium*) made up 50 per cent of two scats collected in western Kansas in summer.

Numerous weed seeds appear in small amounts in raccoon scats. Many of these seeds probably are consumed while the animals are foraging for other foods.

Raccoons rob many of the baited live-traps set by biologists who are studying small mammals. Dr. Henry S. Fitch, Mr. Dennis G. Rainey and Mr. Robert L. Packard, working on the University of Kansas Natural History Reservation, told me of raccoons raiding their traps for the vegetable baits. Dr. Edwin P. Martin reported (*in litt.*) that live-traps, set by him at Hays, Kansas, were disturbed. One raccoon scat was composed entirely of mixed chicken scratch which Martin had used as bait. Hunters of Wallace County relate that raccoons often congregate in ranch feed-lots to eat cottonseed cake that is fed to cattle in winter.

Vertebrate-animal Food

Mammalian remains appear in raccoon scats, especially in winter and spring. In eastern Kansas, the cottontail (*Sylvilagus floridanus*) occurred more often in stomachs and scats of raccoons than did any other mammal. One fecal deposit contained remains of a young rabbit. Its crushed skull was approximately 38 mm. in greatest length. Pocket gophers (*Geomys bursarius*) were more abundant than any other mammal in scats obtained in winter from western Kansas. One scat collected from a cave in Comanche County contained remains of the cave bat (*Myotis velifer*). Other mammals recorded in scats were: *Blarina brevicauda, Peromyscus maniculatus, P. leucopus, Reithrodontomys* sp., *Neotoma micropus, Rattus norvegicus, Microtus* sp., *Synaptomys cooperi, Spermophilus franklinii* and *Sciurus niger.*

Unidentifiable feathers of passerine birds in insignificant amounts were in scats. In February at the Campbell Farm, chicken feathers were in a scat.

Skin and claws of water turtles were found as trace items in both stomachs and scats. In scats, scales were found of unidentified snakes and of two lizards, *Eumeces obsoletus* and *Ophisaurus attenuatus.*

Metatarsal and metacarpal bones of frogs occurred in two scats in winter.

Remains of fish were in scats at all seasons except spring. Raccoons feed on fish especially when water in streams and ponds is low. On July 25, 1954, millions of fish died in the State Lake in Republic County. Numerous raccoon scats composed largely of scales and bones of fish were found along the shore.

Large kills of fish were noted under ice on both Rock Creek and the Wakarusa River in late January, 1954. Channel catfish, carp, green sunfish, redhorse sucker, drum, golden shinner, gold eye, and several kinds of small minnows were found dead. On one occasion, a dead carp, removed from ice by me and placed on the bank, was eaten by a raccoon two days later. When the ice began to melt from these streams, the adjacent banks were covered with tracks of raccoons, opossums, mink and coyotes. Raccoons usually do not eat the heads, some of the vertebrae, and the tails of fish.

Invertebrate-animal Food

Crayfish are eaten in small amounts in summer, autumn and winter, and in sizable quantities in spring, especially in western Kansas. Millipedes and spiders were trace-items in some scats.

Clams are eaten. In late winter and early spring, 1954, the Wakarusa River ceased to flow and consisted of a series of small pools, most of which were less than three feet in depth. Low water, alternately freezing and thawing, killed and exposed hundreds of fresh-water mollusks. Shells of dead clams often were partly open so that it was an easy matter for raccoons to remove the fleshy parts. Raccoons rarely broke or damaged shells.

Raccoons fed on clams beginning in early November, but until February only occasionally. Fresh evidence that raccoons foraged for clams was found on each of 26 days in February; 407 clams of eight species were eaten along one-mile of the Wakarusa River. *Amblema costata* (see Table 15), the most abundant clam there, was eaten more commonly than all other species combined. Clams were eaten until April 8, when showers raised the water-level of the Wakarusa River. Remains of large clams usually were undetected in scats, but snails and small clams (*Sphaerium* sp.) were recognizable.

TABLE 15.

Clams eaten by raccoons along one mile of the Wakarusa River, Douglas County, in February and March, 1954.

Species	Length of shells and number of pelecypods eaten							
	Small less than 2½ inches		Medium 2½ to 4 inches		Large more than 4 inches		Total number	
	Feb.	Mar.	Feb.	Mar.	Feb.	Mar.	Feb.	Mar.
Amblema costata	61	3	37	1	136	29	234	33
Quadrula quadrula and *Q. pustulosa*	56	18	10	10	25	10	91	38
Lampsilus anadontoides and *Liguniea subrasfruta*	34	11	9	9	21	8	64	28
Lasmogonia complanata	4	2	2	1	2	2	8	5
Tritigonia verrucosa	2	4	1	1	1	1	4	6
Anodonta grandis	1	0	0	0	1	2	2	2
Unidentified	0	0	4	0	0	0	4	0
Total	158	38	63	22	186	52	407	112

Grasshoppers, the most important insect-food of raccoons, are consumed in greatest quantities in summer. In autumn, remains of grasshoppers appear less often in scats from western Kansas than in scats from eastern Kansas. In the latter area, grasshoppers, concentrating in corn fields, are available when raccoons forage for corn. In western Kansas, many varieties of sorghum, which are planted more commonly than corn in that area, are unattractive to grasshoppers (see Smith, 1954:430). Consequently, raccoons foraging in cultivated fields have less opportunity to feed on grasshoppers.

Harpalus, a dull, black ground-beetle approximately one inch long, is eaten more commonly than other beetles by raccoons. The small water-beetle (*Tropisternus lateralis*) was in many scats taken in western Kansas. This insect is picked up by raccoons probably when they forage in shallow water. Occasionally a scat contains parts of hundreds of these small beetles. May beetles (*Phyllophaga* sp.) were recorded in scats taken in spring and summer. Adult and larval passalids, which live in rotting logs, were in scats in eastern Kansas in all seasons except winter. Numerous other insects occurred in small amounts in raccoon scats and stomachs.

TABLE 16.

Foods in 22 raccoon stomachs taken in eastern Kansas in the winter of 1952-53.

Food	Per cent frequency	Per cent volume
Vertebrate		17
Rabbit	18	10
Fox Squirrel	5	2
Fish	5	5
Turtle	5	trace
Vegetable		64
Corn	59	53
Acorn	9	7
Echinochloa sp.	5	trace
Cherry	5	trace
Chaetochloa lutescens	5	trace
Unidentified plant fiber	5	5
Insect		19
Grasshopper	23	5
Harpalus sp.	14	5
Pasallidae	9	trace
Unidentified larvae	9	5
Unidentified grubs	5	5

Summary of Seasonal Food Habits

Raccoons are attracted to cultivated crops, especially to corn and sorghum, that make up more than 50 per cent of their food. Native seasonal foods, especially important in autumn, include acorns, hackberry seeds, pokeweed berries, grapes and insects.

According to analyses of scats and stomachs, in winter raccoons feed principally in cultivated fields and, to a lesser extent, along streams. In western Kansas, in spring, more than 70 per cent of the raccoon's food comes from along water courses. In eastern Kansas, in the same season, less than 20 per cent of the raccoon's food is obtained from streams. In summer, raccoons depend largely on insects and ripening native foods, taking each kind of fruit or berry as it becomes available. Vertebrate material, except for fish, was found to be of little importance as food for raccoons in this season.

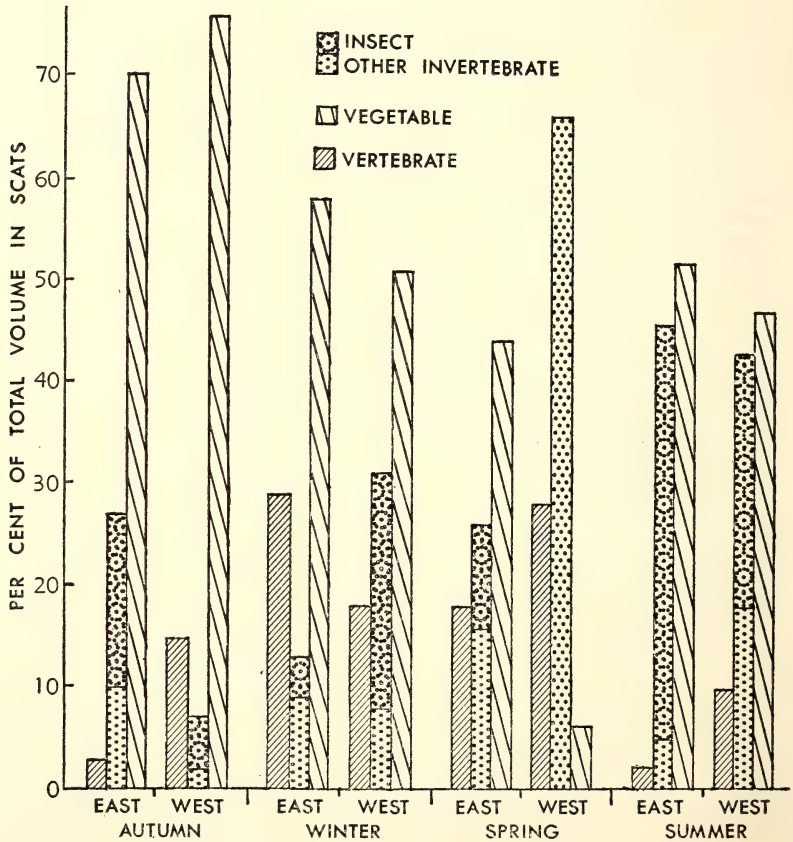

FIG. 10. Summary of the food of the raccoon in Kansas.

TABLE 17.

Analysis of 705 raccoon scats collected from the Campbell Farm, Douglas County, Kansas, from September, 1952, through August, 1954.

SPECIES	AUTUMN (529 scats)		WINTER (47 scats)		SPRING (42 scats)		SUMMER (87 scats)	
	Per cent Frequency	Per cent Volume	Per cent Frequency	Per cent Volume	Per cent Frequency	Per cent Volume	Per cent Frequency	Per cent Volume
VERTEBRATE	....	3	....	25	....	18	....	2
Mammal	....	2	....	18	....	17	....	2
Blarina brevicauda	T	T	....	....	....	....	....	....
Peromyscus sp.	T	T	....	....	....	....	1	1
Reithrodontomys sp.	1	T	2	1	5	2	1	T
Rattus norvegicus	....	....	....	....	2	T	....	....
Microtus sp.	T	T	....	....	....	....	....	....
Spermophilus franklinii	....	....	4	3	....	....	....	....
Sciurus niger	T	T	2	2	5	2	....	....
Sylvilagus floridanus	5	1	26	12	21	12	1	1
Unidentified	3	T	2	T	....	....	....	....
Bird	1	T	9	3	10	T	1	T
Fish	5	1	21	4	....	....	2	T
Amphibian	....	....	4	T	....	....	....	....
Reptile	....	T	....	T	....	1	....	....
Turtle	....	....	2	T	....	....	....	....
Snake	1	T	....	....	....	....	....	....
Eumeces obsoletus	T	T	....	....	....	....	....	....
Ophisaurus attenuatus	....	....	....	....	2	1	....	....
Unidentified	....	....	....	....	7	T	....	....
INVERTEBRATE	....	28	....	14	....	27	....	46
Insects	....	17	....	5	10	10	....	41
Orthoptera	....	12	....	4	....	....	....	32
Locustidae	47	12	21	4	....	....	72	32
Grillidae	....	....	....	....	....	....	2	T
Coleoptera	....	3	....	T	....	8	....	4
Carabidae	....	2	....	T	....	1	....	1
Harpalus sp.	37	2	11	T	10	T	24	1
Galerita sp.	12	T	....	....	7	1	1	T
Calosoma scrutator	....	....	....	....	29	T	2	T
Unidentified	T	T	....	....	....	....	1	T
Hydrophilidae	....	1	....	T	....	T	....	....
Tropisternus lateralis	23	1	2	T	....	....	....	....
Tropisternus glaber	1	T	2	T	....	....	....	....
Hydrocharis sp.	2	T	....	....	5	T	....	....
Dytiscidae	....	T	....	....	....	T	....	....
Cybister sp.	1	T	....	....	2	T	....	....
Passalidae	2	T	....	....	10	2	13	2

TABLE 17.—*Continued.*

SPECIES	AUTUMN (529 scats)		WINTER (47 scats)		SPRING (42 scats)		SUMMER (87 scats)	
	Per cent Frequency	Per cent Volume	Per cent Frequency	Per cent Volume	Per cent Frequency	Per cent Volume	Per cent Frequency	Per cent Volume
INVERTEBRATE (Concluded)								
Scarabaeidae	....	T	....	....	....	4	....	1
Phanaeus sp.	3	T	....	....	....	....	....	....
Phyllophaga sp.	....	....	....	....	5	4	2	1
Copris sp.	T	T	....	....	....	....	....	....
Unidentified	T	T	....	....	....	....	....	....
Cicindelidae	....	T	....	....	....	....	....	....
Cicindela sp.	1	T	....	....	....	....	....	....
Cerambycidae	T	T	....	....	....	....	1	T
Staphylinidae	....	T	....	....	....	....	....	....
Staphylinus maculosus	T	T	....	....	....	....	....	....
Silphidae	....	....	....	....	....	....	....	T
Silpha sp.	....	....	....	....	....	....	1	T
Unidentified	1	T	....	....	....	....	2	T
Homoptera	....	1	....	....	....	....	....	2
Cicadidae	7	1	....	....	....	....	14	2
Diptera	....	T	....	....	....	T	....	....
Stratiomyidae	3	T	....	....	2	T	....	....
Hemiptera	....	T	....	1	....	T	....	T
Pentatomidae	....	T	....	1	....	T	....	T
Acresternum hilare	6	T	11	T	12	T	1	T
Thyanta custator	1	T	9	1	....	....	1	T
Euschistus variolarius	T	T	....	....	2	T	....	....
Belostomatidae	....	T	....	T	....	....	....	T
Benacus sp.	1	T	2	T	....	....	1	T
Hymenoptera	....	T	....	....	....	....	....	T
Eumenidae	....	....	....	....	....	....	1	T
Sphicidae	T	T	....	....	....	....	....	....
Unidentified	T	T	....	....	....	....	....	....
Odonata	....	T	....	....	....	....	....	T
Zygoptera (Agrioniidae)	3	T	....	....	....	....	....	....
Anisoptera	1	T	....	....	....	....	1	T
Unidentified Insects	2	T	4	T	2	T	6	1
OTHER INVERTEBRATES	....	11	....	9	....	17	....	5
Crayfish	29	6	32	6	40	15	24	5
Mollusks	....	5	....	3	....	2	....	T
Anodonta grandis	7	1	2	T	2	T	1	T
Sphaerium striatinum	20	2	9	T	2	T	....	....
Lasmogona complanata	1	1	....	....	....	....	....	....
Proptera alata	T	T	....	....	....	....	....	....
Triodopsis albolabria	T	T	....	....	2	T	1	T
Unidentified Pelecypoda	3	T	....	....	5	T	1	T
Physa sp.	14	1	11	3	12	2	6	T
Gastrocopta armifera	T	T	....	....	....	....	....	....
Helicodiscus parallelus	....	....	....	....	....	....	1	T
Unidentified Gastropoda	T	T	....	....	....	....	....	....

TABLE 17.—*Concluded.*

SPECIES	AUTUMN (529 scats)		WINTER (47 scats)		SPRING (42 scats)		SUMMER (87 scats)	
	Per cent Frequency	Per cent Volume	Per cent Frequency	Per cent Volume	Per cent Frequency	Per cent Volume	Per cent Frequency	Per cent Volume
VEGETABLE	....	66	....	60	....	51	....	52
Grains	....	39	....	54	....	42	....	9
Zea mays	58	39	77	54	67	42	28	9
Sorghum vulgare	....	....	2	T	....	....	....	....
Nuts	....	15	....	5	....	6	....	1
Quercus sp.	26	15	9	5	10	6	1	1
Juglans nigra	T	T	....	....	....	....	....	....
Fruits and Berries	....	12	....	1	....	....	....	41
Vitis vulpina	20	9	....	....	....	....	21	9
Phytolacca americana	5	1	....	....	....	....	1	T
Morus rubra	T	T	....	....	....	....	21	12
Asimina triloba	3	2	....	....	....	....	....	....
Celtis occidentalis	T	T	2	1	....	....	18	11
Ribes sp.	....	....	....	....	....	....	9	4
Prunus serotina	....	....	....	....	....	....	8	5
Prunus persica	....	....	....	....	....	....	1	T
Smilax sp.	1	T	2	T	....	....	....	....
Cornus sp.	1	T	....	....	....	....	....	....
Celastrus scandens	T	T	....	....	....	....	....	....
Miscellaneous Seeds	....	T	....	T	....	T	....	T
Amaranthus retroflexus	1	T	9	T	....	....	....	....
Chenopodium sp.	1	T	4	T	....	....	....	....
Juniperus virginiana	1	T	....	....	....	....	1	T
Polygonum sp.	T	T	2	T	....	....	....	....
Menispermum canadensis	T	T	....	....	....	....	1	T
Euphorbia dentata	....	....	....	....	....	....	1	T
Chaetochloa lutescens	1	T	2	T	....	....	....	....
Cenchrus longispinus	T	T	....	....	....	....	....	....
Elymus canadensis	....	....	....	....	....	....	1	T
Desmodium illinoensis	T	T	....	....	....	....	....	....
Unidentified Plant Fiber	T	T	....	....	5	3	1	1
Unidentified Seeds	5	T	9	T	7	T	8	T

TABLE 18.

Analysis of 103 raccoon scats collected from western Kansas from September, 1952, through August, 1954.

SPECIES	AUTUMN (42 scats)		WINTER (31 scats)		SPRING (6 scats)		SUMMER (24 scats)	
	Per cent Frequency	Per cent Volume	Per cent Frequency	Per cent Volume	Per cent Frequency	Per cent Volume	Per cent Frequency	Per cent Volume
VERTEBRATE	....	15	....	18	....	28	....	10
Mammal	....	1	....	14	....	28	....	T
Myotis velifer	....	....	....	....	17	16	....	....
Peromyscus maniculatus	2	T	3	1	....	....	....	....
Neotoma sp.	....	....	3	3	....	....	....	....
Microtus sp.	2	1	....	....	....	....	....	....
Synaptomys cooperi	....	....	....	....	....	....	4	T
Geomys bursarius	....	....	10	5	....	....	....	....
Sylvilagus floridanus	....	....	3	2	17	12	4	T
Unidentified	2	T	13	3	....	....	....	....
Bird	10	T	16	1	....	....	4	1
Fish	24	13	....	....	....	....	25	9
Amphibian	....	....	3	T	....	....	4	T
Reptile	....	T	....	3	....	....	....	....
Turtle	5	T	3	T	....	....	....	....
Snake	....	....	3	3	....	....	....	....
INVERTEBRATE	....	7	....	31	....	67	....	43
Insects	....	5	....	23	....	T	....	25
Orthoptera	....	1	....	16	....	....	....	21
Locustidae	33	1	55	16	....	....	38	20
Gryllidae	....	....	6	T	....	....	8	T
Coleoptera	....	4	....	6	....	T	....	4
Carabidae	....	T	....	T	....	....	....	1
Harpalus sp.	12	T	6	T	....	....	17	1
Pterostichus sp.	....	....	....	....	....	....	4	T
Unidentified	2	T	3	T	....	....	4	T
Hydrophilidae	....	3	....	6	....	T	....	T
Tropisternus lateralis	33	3	19	6	17	T	4	T
Tropisternus glaber	....	....	10	T	17	T	4	T
Hydrocharis sp.	....	....	....	....	....	....	4	T
Dytiscidae	5	T	....	....	....	....	4	T
Scarabaeidae	....	T	....	T	....	....	....	2
Phanaeus sp.	7	T	3	T	....	....	4	T
Phyllophaga sp.	....	....	....	....	....	....	4	2
Unidentified	5	T	3	T	....	....	....	....
Chrysomelidae (Diabrotica)	5	T	....	....	....	....	....	....
Curculionidae	....	....	....	....	....	....	4	T
Dermestidae	2	T	....	....	....	....	....	....
Unidentified	....	....	13	T	....	....	4	T
Diptera	....	T	....	....	....	....	....	T
Stratiomyidae	5	T	....	....	....	....	8	T
Unidentified larvae	....	....	....	....	....	....	4	T

TABLE 18.—*Concluded.*

SPECIES	AUTUMN (42 scats)		WINTER (31 scats)		SPRING (6 scats)		SUMMER (24 scats)	
	Per cent Frequency	Per cent Volume	Per cent Frequency	Per cent Volume	Per cent Frequency	Per cent Volume	Per cent Frequency	Per cent Volume
INVERTEBRATE (Concluded)								
Hemiptera	....	T	....	T	....	....	....	T
Belostomatidae (*Belostoma*)	5	T	3	T	....	....	8	T
Lygaeidae	....	....	....	....	....	....	4	T
Odonata	....	T	....	1	....	....	....	T
Zygoptera (*Agrion* sp.)	2	T	....	....	....	....	17	T
Anisoptera	5	T	3	1	....	....	4	T
Unidentified Insects	2	T	....	....	....	....	4	T
Other Invertebrates	....	2	....	8	....	67	....	18
Crayfish	19	2	19	1	67	54	42	18
Millipedes	....	....	3	T	17	1	....	....
Spiders	....	....	3	T	....	....	8	T
Mollusks	....	T	....	7	17	12	....	....
Sphaerium sp.	....	....	3	2	....	....	....	....
Physa sp.	....	....	19	5	17	12	....	....
Helisoma trivolvis	....	....	3	T	....	....	....	....
Unidentified Gastropoda	2	T	....	....	....	....	....	....
VEGETABLES	....	76	....	51	....	5	....	44
Grains	....	34	....	50	....	5	....	6
Zea mays	....	....	32	22	....	....	4	1
Sorgum vulgare	62	34	29	28	33	5	8	5
Fruits and Berries	....	39	....	T	....	....	....	34
Vitis vulpina	33	9	3	T	....	....	25	12
Phytolacca americana	36	11	3	T	....	....	....	....
Morus rubra	2	T	....	....	....	....	33	19
Celtis occidentalis	45	18	....	....	....	....	....	....
Ribes sp.	....	....	....	....	....	....	4	T
Prunus serotina	....	....	....	....	....	....	8	2
Smilax sp.	2	1	....	....	....	....	....	....
Cornus sp.	....	....	3	T	....	....	....	....
Miscellaneous Seeds	....	3	....	1	....	....	....	4
Amaranthus retroflexus	....	....	3	T	....	....	....	....
Juniperus virginianus	....	....	....	....	....	....	4	T
Polygonum lapathofolium	....	....	....	....	....	....	8	4
Euphorbia marginata	....	....	6	T	....	....	4	T
Euphorbia dentata	....	....	....	....	....	....	4	T
Chaetochloa lutescens	....	....	3	T	....	....	....	....
Cenchrus longispinus	....	....	3	T	....	....	....	....
Elymus canadensis	....	....	....	....	....	....	4	T
Aristida longasepta	....	....	....	....	....	....	4	T
Bromus sp.	....	....	....	....	....	....	4	T
Panicum capillard	....	....	3	T	....	....	4	T
Echinochloa crusgalli	....	....	3	T	....	....	....	....
Opuntia sp.	....	....	10	T	....	....	....	....
Rhus radicans	5	T	....	....	....	....	....	....
Trap bait (mixed chicken scratch)	2	2	....	....	....	....	....	....
Unidentified Plant Fiber	2	1	3	1	....	....	....	....
Unidentified Seeds	....	....	3	T	....	....	13	T

Movements

Whitney and Underwood (1952a:117-118) followed one animal five miles in a straight line and state that when food is scarce raccoons travel far to areas of good feeding, and often congregate in an area where food is plentiful. On one occasion the mobility of a raccoon in western Kansas could be determined. A raccoon scat, composed of 80 per cent hackberry seeds, was found at a small pond on the experimental farm on the campus at Fort Hays State College, Ellis County. The nearest hackberry trees were in two draws, 1.3 and 1.4 miles distant; thus, this animal traveled at least more than a mile in search of food. In Michigan, Stuewer (1943: 255) found that, if food was locally abundant, raccoons usually ranged within an area no more than one mile in diameter.

The average distance walked, as reported by 443 hunters, was 4.2 miles, and the average number of raccoons scented by dogs, as reported by 440 hunters, was 4 raccoons per hunt. It can be inferred that the range of a raccoon when being chased by a dog is one mile. Many raccoons will tree after a short chase; others will run several miles. One hunter from western Kansas followed a raccoon for eight and one-half miles.

Most information on movements of raccoons in my study was obtained along a one-mile stretch of the Wakarusa River at the Campbell Farm. Along this stretch, 66 strips, two feet wide averaging 12 feet long, were raked. Each strip extended from the border of vegetation on one side of the River to the border on the other side. These strips (see Plate 4) were from 10 to 330 feet apart (average, 70 feet). In addition to the raked-strips that crossed the river's course, twenty-one raked strips crossed an unused road, which led through the woods on the south side of, and parallel to, the river. A circuit approximately two miles long was walked by the observer each day, weather permitting, and the tracks of various furbearers that crossed these raked strips were recorded, after which the strips were reraked.

For studying movement of raccoons, the use of strips instead of live-traps has advantages as follows: normal activity of the mammal is not disturbed; the animal is not attracted by baits to one area night after night; tracks record the presence of several or all animals active in the area each night; live-traps and other special equipment are unnecessary; and since time need not be spent in checking traps, more attention can be paid to other signs of activity.

Obviously the use of tracks has limitations: the animals are not seen or examined; the movements of individual animals, in most cases, can not be determined; and precipitation and freezing reduce the chances of making accurate track-counts.

This track-count method of determining movement was devised to ascertain the amount of activity of the raccoons on the area and to correlate this movement with environmental conditions. The number of times tracks crossed raked strips was an index of movement regardless of whether one or more than one raccoon made the tracks. It is logical to suppose that one animal, crossing 10 strips while moving up and down the stream to feed, could make as many tracks as ten animals which crossed only one strip while going to the stream only to drink. When one raccoon is exceptionally active, however, most other raccoons in the population usually are active.

FIG. 11. Correlation between air temperature and total movement of raccoons at the Campbell Farm. The numerals denoting total movement are the average number of times per 24-hour interval that raccoons crossed raked areas, in 10-day intervals.

There are several environmental conditions that might be expected to affect the raccoon's activity at any given time. Some of these are wind velocity, temperature, precipitation, degree of moonlight, humidity and atmospheric pressure. In addition, the physiological condition of the animal should be considered. Actually, wind velocity and atmospheric pressure seem not to influence the movement of raccoons. Snow influences movement. In Iowa, Cabalka (1952:29) noted that raccoons descended the den trees but when touching their feet to snow on the ground returned to the den, even if only a trace of snow was present. When the snow began to melt, raccoons became active even though the snow was as deep as five inches in some places. At the Campbell Farm, raccoons behaved as described above by Cabalka. Hunters in Kansas reported, however, that raccoons were active when snow first covered the ground.

Temperature of the air more than any other factor, influences the activities of raccoons in the colder times of the year. Most of the early writers of natural history believed, although incorrectly, that raccoons hibernated in cold weather. Actually, the animals may become sluggish and remain quiet in a protective den during such weather (see Whitney and Underwood, 1952a:108-116). Cabalka (*op cit.*:26-28) was the first, to my knowledge, to use a numerical index for the movement of raccoons. The index was based on tracks, scats, numbers of raccoons scented by dogs, and hair found in wire-catching devices. He found that raccoons in winter usually were active when temperatures increased and inactive when temperatures decreased. Rapid increases and decreases in temperatures influenced raccoon movements more than gradual changes. Shaffer (1948:60) and Whitney and Underwood (*op. cit.*: 110-111) also commented on raccoon movements in relation to temperature but did not, in any way, measure the effects.

Track counts on the Campbell Farm showed that movements of raccoons decreased markedly when average daily temperatures (average of 8 p. m., 10 p. m. and midnight temperature) were low in late autumn and early winter. Figure 11 shows that the curves for temperature of the air and for movement of raccoons were closely correlated during these seasons.

Movement of raccoons in autumn and winter on the study area corresponded to the movement of raccoons as reported by cooperating hunters, who kept records of 1475 raccoons scented by their dogs, 1185 treed, and 843 taken in the four-month period of October, 1953-January, 1954. The first high point (October 1-4) in Figure 12 probably reflects the normally high population of raccoons present at the beginning of the season. The curves are closely correlated even though size of the raccoon population diminished as the season progressed, and compare favorably with the curves for temperature and raccoon-activity at the Campbell Farm. In late December and January, few tracks were counted on strips at the Campbell Farm; frozen ground made readings impossible there on some days. Also, the counts were too few to show minor fluctuations in movement that may have occurred at low temperature.

The phase of the moon or the brightness of the night is believed by many hunters to affect the movements of raccoons. Hunters' reports of raccoons scented, treed or taken per night were highest in the phases between full moons. In Virginia, "trapping records and field notes bear testimony that raccoons . . . are comparatively inactive during periods of moonlight" according to Shaffer (1948:60). Data from track records on the Campbell

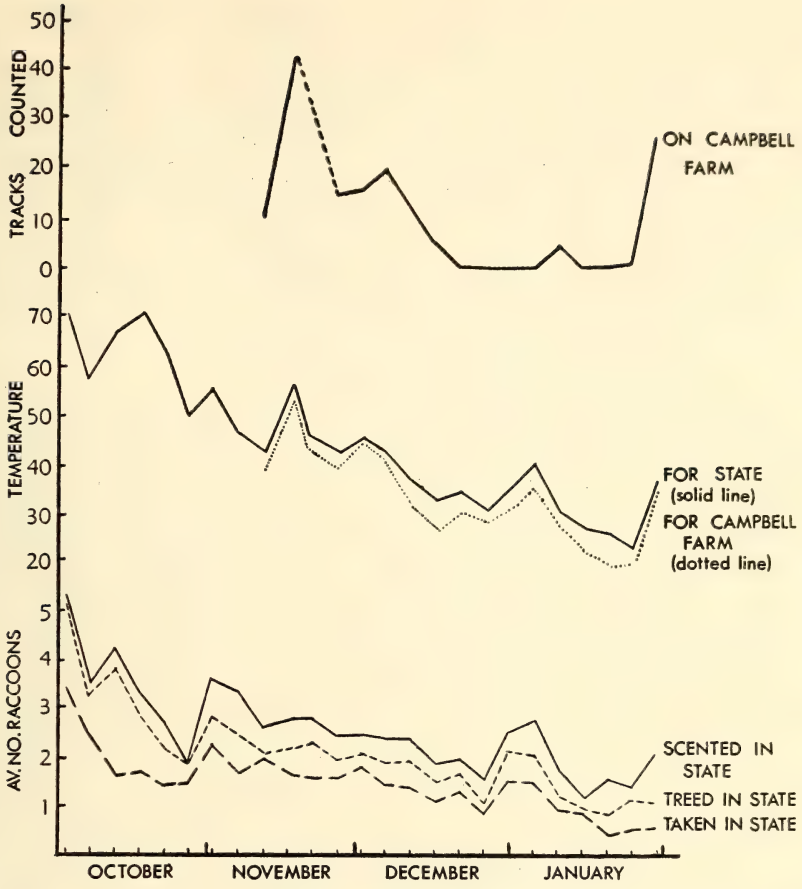

FIG. 12. Correlation between air temperature and activity of raccoons as reported by hunters using dogs. Also, the comparative activity of raccoons on the Campbell Farm and throughout Kansas is shown. Average daily temperatures for the counties from which these raccoons were reported are combined in 5-day intervals. The number of raccoons scented, treed and taken are the average number of raccoons per hunt, per day.

Farm indicate that the phase of the moon may influence movement; track readings were fewer when the moon was full and more numerous in phases between the full moons. The influence of moonlight, however, was masked by the effect of temperature which was at a peak in the dark of the moon in each of the three months.

During the breeding season, February and March, raccoons became much more active than in other months. Even so, low temperatures in these months retarded movements considerably. An increase in temperature to above approximately 35°F was followed by much activity. To show that movement, on a daily basis in the breeding season, also was influenced by temperature, the following are the lowest and highest temperatures and the evidence of raccoon movement on each of several days of these months on the Campbell Farm:

Date	Temperature (Degrees F)	Movement (Total crosses)
February 3	42 (high)	81
February 6	27 (low)	33
February 8	48 (high)	38
February 11	24 (low)	17
February 14	67 (high)	39
February 15	45	107
February 16	38 (low)	40
February 17	47	124
February 18	51 (high)	89
February 21	35 (low)	63
February 22	44 (high)	164
March 4	25 (low)	4
March 12	37 (high)	42
March 13	21 (low)	3
March 16	50 (high)	80

Temperature and movement are well correlated; the breeding season might be retarded or prolonged if the temperature never rose above 35° F in February. In early April, movement of raccoons along the Wakarusa River decreased and was comparable to that in late autumn at similar temperatures. From April through summer, after temperatures had risen above 40° F, the discrepancies between the curves for temperature and activity indicate that high temperatures actually retard movement. Data for these months are few because tracks were obliterated by frequent showers and high water covered the raked areas.

Comparison of the total movements of raccoons in different seasons is unprofitable because of seasonal changes in the size of the population and becase most of the data are based on movement of the animals in only one habitat, along water. From late winter through spring, raccoons foraged to a larger extent along streams, and more food was obtained from and adjacent to water than in other seasons. Perhaps the increased activity observed in late March reflects concentration of animals along the stream in search of food such as mollusks and fish which are more vulnerable to predation at this time of year. There were fewer tracks along the stream from late April to mid-July. Possible reasons are: The population is smallest at that time of year; raccoons may be feeding in woods or fields; there is less movement because females are caring for their young (perhaps females move no more, or no farther from their dens, than is necessary to forage); high temperature and humidity in the river bottom may cause the animals to avoid the area; less movement may be required because food is more abundant and more concentrated; and at times of high water raccoons may forage less along the water's edge.

Improvement of the track-technique might provide a means to determine the home range. Animals might be captured alive and one or more toes clipped so that tracks of individual animals could be identified; and raked strips could be placed in woodlands, brushlands, fields and other habitats away from the stream, as well as along streams, so that tracks could be counted to determine movements in all of these places. Raked strips along an infrequently used dirt road, running at right angles to the stream and passing through a variety of habitats, would be preferred. These improvements might reveal also population turnover, and movements into and out of various habitats. Final results might be more fruitful than those obtained from a study through use of live-traps alone.

Economic Importance

Raccoon Trapping

Raccoons in Kansas are captured with steel traps or with hounds that locate and tree the animals for the hunter. Few, if any, persons now trap primarily for raccoons in Kansas; usually these animals are taken in sets prepared for other fur animals.

Table 19.

Analysis of the 1951-52 raccoon harvest, as determined by questionnaires and field interviews.

	Trappers only	Hunters and trappers	Hunters only	Total
First Response				
Number licenses	31	10	9	50
Average number raccoons taken	3.6	23.7	33.1	12.9
Second Response				
Number licenses	69	23	19	111
Average number raccoons taken	2.7	14.6	23.9	8.8
Third Response				
Number licenses	32	12	16	60
Average number raccoons taken	1.5	15.9	22.5	10.0
Field Interview				
Number licenses	27	11	16	54
Average number raccoons taken	3.0	19.6	30.3	14.5
Total Estimate For State*				
Number licenses	4713 (54.6 per cent)	1638 (20.6 per cent)	2097 (24.8 per cent)	8448
Per cent of raccoons taken	12.3	30.1	57.6	
Average number raccoons taken	2.7	19.3	28.7	12.4
Franklin County				
Number licenses	77	25	23	125
Average number raccoons taken	1.7	16.9	23	8.6

* See Stains (1951:11) for method of weighting in the analysis.

Some hunters complain that trappers catch too many raccoons and thus spoil their sport, and that traps constitute a danger to their dogs. Trappers complain that dog-handlers catch too many raccoons, reduce their chances of a good catch by running their dogs through their trapping areas, and spring or take traps. The returns of a questionnaire to buyers of trapping licenses in 1951-52 emphasized the controversy between trappers and hunters. These returns

showed, however, that many persons who use steel traps also hunt raccoons with dogs. Of 275 purchasers of trapping licenses interviewed, 55 per cent were trappers and only 25 per cent were hunters; the remaining 20 per cent were persons who both trapped and hunted. The persons who trapped exclusively, took only 12 per cent of the total raccoon harvest, an average of three raccoons per trapper. Hunters using dogs harvested 58 per cent of the raccoons, an average of 29 raccoons per hunter (Table 19).

In Franklin County in 1952 (see Table 19) trappers averaged only 1.7 raccoons whereas hunters averaged 23 raccoons; 61.6 per cent of the licenses were purchased by trappers and only 18.4 per cent by hunters.

Raccoon Hunting

Number of Hunters.—Approximately 45 per cent of the trapping licenses sold in 1951-52 were bought by persons who hunt with dogs. There are other hunters who do not purchase a license; perhaps they hunt with those who do buy licenses. Approximately 4,250 persons who own dogs actively hunt raccoons in Kansas. These hunters often are accompanied by interested sportsmen, school boys and others who do not own dogs. The 451 raccoon hunters who responded took an average of 7.8 persons with them in the course of the 1952-53 season. From these figures an estimated additional 30,000 citizens enjoyed the sport of raccoon hunting. Dog-owners also often hunt with others who own dogs; each dog-owner hunted with an average of 4.2 other dog-owners in the course of the season. The above data indicate that raccoon hunting is often a community venture as well as an individual sport.

Hunter Success.—Hunters with dogs took many more raccoons than did trappers (see Table 19) in the 1951-52 season which extended over a period of two months. In 1952-53, the season for use of dogs was extended to four months. The average catch reported by 443 raccoon hunters was 28.5 animals in 1952-53 or 7 raccoons per month. Of these same hunters, 438 reported an average catch of 33.3 animals in 1951-52 or 17 raccoons per month, an average similar to that for 9 hunters in 1951-52 who responded first in the 1951-52 trapping survey (see Table 19). Consequently, even though the season was longer in 1952-53 than in 1951-52 the harvest was smaller—possibly owing to a smaller population of raccoons and a lower value of the pelts in 1952-53. The 71 cooperating raccoon hunters, responding in 1953-54, averaged 28 raccoons or 7 per month, approximating the 1952-53 average catch per hunter of 28.5 animals.

My figures of the average take reported in both 1952-53 and 1953-54 are high because successful hunters more often than others answered the questionnaire. The hunter or trapper who responds first to a questionnaire, on the average, is more successful than one who responds later. Since only one mailing of these 1952-53 and 1953-54 questionnaires was made and since no follow-up field-interviews were made, the 1952-53 and 1953-54 averages are biased and are more comparable to the first response in 1951-52 (see Table 19). In addition, several of the hunters who responded in 1952-53 and 1953-54 probably fall into the "hunter and trapper" category which would again tend to lower the average take for those years.

Dogs.—Raccoon hunters use dogs of mixed breeds as well as pure-bred dogs. Some good dogs sell for several thousand dollars each. The most popular breeds of 'coon hounds are the Bluetick, Redbone, Black and Tan, Redtick, Plott, and Treeing Walker; other breeds and crosses also are successful trailers.

According to data from questionnaires, the Kansas raccoon hunter owns an average of 2.8 hunting dogs and takes an average of 2.9 dogs on each hunt. It is calculated that there are approximately 12,000 'coon hounds in Kansas or one dog for every nine raccoons taken in the season of 1951-52. Feeding these dogs is, in itself, a major expenditure for the hunter. Hunters of all game and fur species in North Carolina expended an average of approximately $20 per year to maintain their dogs (see Stains and Barkalow 1951: 23). If $20 is a fair estimate of the annual cost of maintaining a hunting dog in Kansas, the cost of upkeep of all raccoon hunting dogs is approximately $240,000 annually. This figure includes neither the original cost of the dogs nor construction and maintenance of kennels.

The Hunt.—In 1953-54, 486 hunters who responded to the questionnaire, traveled by car an average of 21 miles per hunt. The average mileage traveled increased as the season progressed: in October an average of 17.9 miles, in November, 19.9, in December, 22.5 and in January, 23.3 miles. This increased amount of travel indicates that hunting became progressively poorer in local areas and that hunters were obliged to travel farther from home to better hunting grounds.

In 1952-53, on 443 hunts, a hunter walked an average of 4.2 miles per hunt.

In 1953-54, fifty-one hunters kept records of the duration of each of their 503 hunting trips. The average time spent hunting was 3.9 hours (see Figure 13) and most of the hunting was done between

the hours of 8 and 11 p. m. although the records show that some hunts began as early as 6 p. m. and some lasted to as late as 6 a. m. (Figure 14).

Some dog-owners hunt on almost every night of the season; others hunt on only one or two nights. Twenty-one persons went raccoon hunting an average of 21 nights in 1951-52, 447 hunters averaged 24 hunts in 1952-53, and 41 hunters averaged 22 hunts in 1953-54.

Training season.—A training season in October, established so that hunters could train and condition their dogs in the field for several weeks prior to the opening of the season, was allowed beginning in 1949 and discontinued in 1952. For the 1952-53 hunting season, of 451 hunters giving their opinions of the training season, 55 per cent favored the training season and 45 per cent opposed it. The large number of opponents indicates that damage to raccoon populations may be severe.

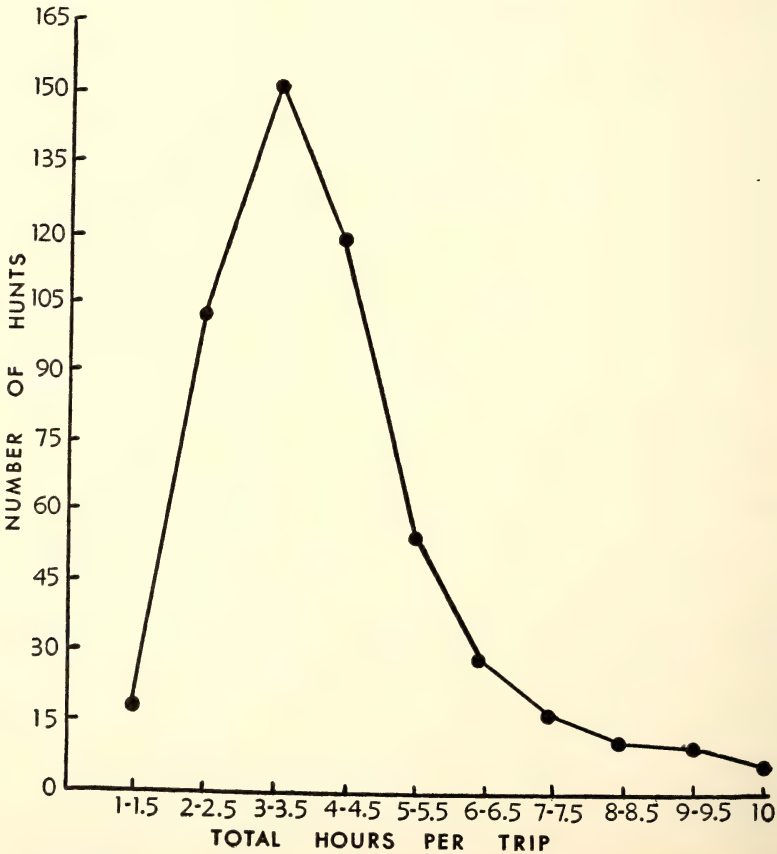

Fig. 13. Amount of time spent in the field by raccoon hunters on 503 hunting trips in Kansas

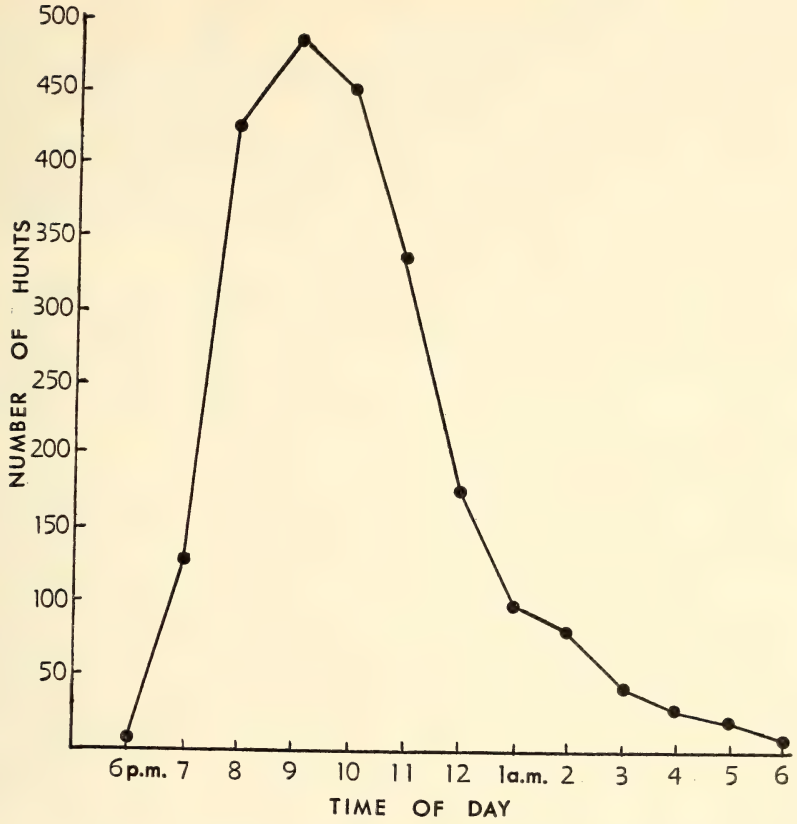

FIG. 14. Hours when raccoon hunters were in the field; 503 hunting trips are represented.

Field Trials.—Field trials are a popular sport with many raccoon hunters. Some travel hundreds of miles going from one field trial to the next but most participants are local people. Dogs entered in field trials are not necessarily the best dogs for the average hunt. Speed and ability to trail are of prime importance in field trials. In the live chase, a dog needs these characteristics but also should have sufficient stamina to hunt for several hours and have the ability and the courage to attack a raccoon. Of 453 hunters interviewed by questionnaire in 1952-53, 27 per cent participated in at least one field trial, and other hunters attended the trials as observers.

Restocking.—More than 2000 raccoons have been purchased from other states and released by hunters and clubs (see page 26); the voluntary expenditure was at least $12,000 over a 15-year period. Many hunters in Kansas capture raccoons alive in season and release them in their hunting territories after the season closes.

Value of the Pelt and the Meat of the Raccoon

The value of raccoon pelts fluctuates from year to year. Since 1943-44, according to Sanderson (1951b:528), the price received for a raccoon pelt has gradually decreased. This progressively lower value has resulted largely from changes in fashion, ladies preferring to wear coats of short-haired pelts instead of coats of long-haired pelts. For raw raccoon pelts, Kansans received in 1951-52 an average of $1.95; in 1952-53, $1.21; in 1953-54, $1.04.

Persons taking raccoons usually receive as much for the unskinned animal as for the prepared pelts because the carcass, if fresh, can be sold as meat by the fur-buyer for almost as much as he obtains for the pelt. Trappers and hunters interviewed in 1951-52 received an average price of $1.99 for 565 unskinned raccoons and $1.91 each for 1549 prepared pelts.

Kansans prefer the meat of raccoons to the meat of opossums and other fur-bearers. Of 12,716 raccoons taken by 425 hunters in 1952-53, the meat of 3845 animals (9.0 per hunter) was eaten, the meat of 4177 animals (9.8 per hunter) was fed to their dogs, cats, chickens and pigs, the meat of 747 animals (1.8 per hunter) was sold at an average of 96 cents per animal, and the meat of 3947 raccoons (9.3 per hunter) was either discarded or sold with the pelt.

Of 14,270 pelts marketed by 540 hunters and trappers in the seasons of 1951-52 and 1952-53, only 6.8 per cent were sold out-of-state. Pelts sold out-of-state brought an average of 35 cents less than those sold instate in 1951-52 and an average of 12 cents more in 1952-53.

Relation of the Raccoon to Agriculture

Much of the raccoon's native food has been reduced or eliminated owing to the ever-increasing utilization of land by man. Raccoons are opportunists and, when native foods are scarce, take edible foods cultivated by man. In many areas raccoons have become accustomed to cultivated foods, principally corn. As seen in the section of food habits (page 42), corn is taken in abundance and now seems to be a staple food of the raccoon in most parts of Kansas. Raccoons feed on corn when it is in the roasting-ear stage and continue to feed in corn fields until the corn no longer is available.

Of 451 raccoon hunters interviewed in 1952-53, only 28 reported that raccoons were doing damage in their areas. These reports were 20 claims of damage to chickens, 17 to corn, 5 to gardens and

melon patches, and 3 to buildings. Approximately 60 per cent of the 451 hunters live in the corn belt (see "A" figure 6) but only three per cent of the hunters living in the better corn-producing areas reported damage. Approximately 9 per cent of the hunters in area "B" reported damage and 14 per cent in area "C". This indicates that damage by raccoons increases in areas where corn is planted in only a few fields.

Management

Trapping and Hunting Regulations

The trapping season for fur-bearers is open from December 1 through January 31. Beginning in 1953, the open season for taking raccoons was extended from October 1 to January 31.

Factors to be considered when establishing time and length of the season for taking raccoons include: Time when pelts are prime, sporting qualities of the animal, mating season, weather, complaints of damage, abundance of raccoons, and desires of hunters and trappers.

Taking raccoons only when their pelts are prime is of major importance if the hunter, and the public, is to receive the maximum benefit. Unprime pelts have little value. By the first of December the pelts of most raccoons in Kansas are in "prime" condition; that is to say, the pelage is fully grown. In late January and early February, the fur of many animals is worn and molting, and pelts are of less value in the fur-trade.

If a raccoon will not lead the dogs on a good chase or fight fiercely when cornered, some of the sport, from the hunter's standpoint, is lost. Ideally therefore, the hunter should want raccoons both experienced and large. Many young animals are small and remain with their litter-mates in September, October and even early November. When chased, they climb the first tree found and taking them offers little sport to hunters. By mid-November most first-year animals are large enough to provide adequate sport for the chase.

Breeding occurs in late January in Kansas but attains a peak between mid-February and early March. A hunting and trapping season ending on January 31 would not affect appreciably the breeding season.

When weather is severe in December and January, raccoons travel little and hunters and trappers are discouraged by low temperatures and by poor success. Hunters, interviewed by ques-

tionnaire, were not in agreement as to when the season for taking raccoons should be open, but 60 per cent of the persons favored a season lasting two months. Thirty per cent of the hunters favored an open season from December 1 through January 31, while 19 per cent favored a season from November 15 through January 15.

When raccoons are numerous, corn and other cultivated crops may be damaged, and farmers complain. If complaints are justifiable, a large proportion of the raccoon population could be removed by opening the hunting season earlier. If complaints are localized, the offending raccoons can be caught and removed. On the other hand, when raccoons are not numerous, the hunting season should be shortened. An alternative measure is to regulate the take of raccoons by setting a daily or seasonal bag-limit. A bag-limit necessitates some method of accounting for animals taken. One method (see Noren, 1941a:22-25) is to issue, at the time when licenses are purchased, metal tags for attachment to pelts taken.

Permission to train and condition hounds in the field before the hunting season opens is desirable from the point of view of dog handlers, but illegal kill of raccoons by the unscrupulous hunter, in the course of running his dogs, is difficult to control. Even conscientious hunters may see no harm in forcing at least one raccoon out of a tree so that the pups may learn how to fight. The obvious result is a large kill of young raccoons having unprime pelts. All facts considered, the training season seems to be more detrimental than beneficial. Approximately 45 per cent of the hunters interviewed are also of this opinion. Other successful methods, not detrimental to raccoon populations, for training young dogs are suggested by Whitney and Underwood (1952b:97-118).

Based on my study, the best season for taking raccoon pelts in Kansas is November 15 through January 31. In this period most pelts are prime, and those of first-year animals are of sufficient size to bring acceptable prices. There is little overlap with the breeding season of late winter. Two weeks in November would provide more mild weather for night hunting with dogs and thus would please many hunters.

Education

Citizens should be informed, through a well-planned educational program, of the economic importance of raccoons and other wildlife resources. Most successful are programs at the grade-school

level because children are more easily taught wise conservation practices than are adults. Effective publicity, however, can inform adults of the values of wildlife. Leaders of educational programs should make maximum use of findings of biological studies.

Trappers and hunters of raccoons often learn from one another methods for preparing pelts. If methods learned by this means are improper, lower prices per pelt result. Most fur-buyers can suggest improvements in pelting techniques, which will increase the amount per pelt received by both the skinner and the fur-buyer.

Practices, which can be discouraged through education, include killing young raccoons or entire family-groups early in the season, discarding animals in the field, felling den trees, and excessive killing of raccoons in local areas causing marked reduction of breeding stocks.

Habitat Management

Sportsmen, as individuals or as local groups, can improve habitat for raccoons and other wildlife by sponsoring programs to preserve den trees and mature nut-bearing trees, eliminate pollution, prevent fires, and encourage good soil conservation practices.

Corn, because it is the most attractive food for raccoons in Kansas, could be planted on one-acre food patches in suitable places where this plant is not grown extensively. Such patches serve to localize raccoons for better hunting and provide food for other wildlife as well (see Johnson, 1939:52-54).

Streams and ponds, free of pollution, provide necessary habitat for raccoons. Small mud or log dams constructed across streams (see Johnson, *op. cit.*:54) provide deep pools where invertebrate foods can flourish and also may provide the only water in the stream in times of drought.

Hollow trees, suitable as dens for raccoons, are unavailable or scarce in many forested areas. In some places, homes in trees are used less than dens in the ground. Forested areas can be made more attractive to raccoons by constructing den boxes.

A wooden box, 14 inches square and 48 inches high with an entrance 8 inches in diameter near the top of the box, makes a suitable den. Boxes of this sort can be placed at heights of at least 25 feet in suitable trees, with the box entrance on a side next to the trunk so that a raccoon can readily enter.

SUMMARY

1. The ecology and economic importance of raccoons were studied using two principal methods: field investigation and questionnaires to hunters and trappers.
2. Eastern Kansas provides better habitat for raccoons than western Kansas. Parts of western Kansas lack water, cover and food, especially corn.
3. The highest raccoon population occurs where corn is grown extensively in Kansas.
4. Factors which have affected the distribution and density of raccoons in Kansas are: Ability of raccoons to adapt to cultivated crops; increased acreage of cultivated crops; availability of waste grains, especially corn, in winter and spring; increase in hunting pressure from the early 1920's until World War II; decrease in hunting pressures during World War II; and the decline in value of raw pelts.
5. A distemperlike disease, prevalent in eastern Kansas in 1952-53, seemed to be a factor causing the decline of the raccoon population in 1953-54.
6. Raccoons in Kansas use ground dens more often than tree-holes as homes.
7. The raccoon's most important vertebrate competitors for food in eastern Kansas are fox squirrels, opossums, red foxes, cardinals, cottontail rabbits, striped skunks, blue jays, red-eyed towhees, bobwhite quail, tufted titmice, woods mice and muskrats; and in western Kansas, ring-necked pheasants, opossums, striped skunks, cottontail rabbits, fox squirrels, badgers, and deer mice.
8. The peak of the breeding season is in late February in northeastern Kansas, but breeding occurs from late December to June.
9. Most litters are born in late April and early May. The number per litter varies from 4 to 7; the average is 4.6 young per litter.
10. The average weight of 559 raccoons reported by cooperating hunters was 17.6 pounds. Males weigh, on the average, 2 pounds more than females. On the fertile soils of western Kansas, heavier raccoons are found than elsewhere in the State.
11. In Kansas, more than 55 per cent of the raccoon's diet is vegetable material; corn is the most important single item of food.

12. Temperature of the air, more than any other climatic factor, influences the activities of raccoons.
13. Trappers take only 12 per cent of the raccoons harvested annually. Those who hunt with dogs or both hunt and trap take the remainder.
14. The average take per hunter, was 28.7 raccoons in 1951-52, 28.5 raccoons in 1952-53, and 28.0 raccoons in 1953-54.
15. The average price of raw raccoon-pelts was $1.95 in 1951-52, $1.21 in 1952-53, and $1.04 in 1953-54.
16. Approximately 4,250 raccoon hunters own approximately 12,000 'coon hounds in Kansas, and an estimated total of 35,000 citizens enjoy the sport of raccoon hunting each year.
17. Hunts averaged 3.9 hours in length and usually most of the hunting was between 8 p. m. and 11 p. m. (see fig. 19). On the average, 2.9 dogs per hunt were used. The hunter walked, on the average, 4.2 miles per hunt.
18. A preseason training period for dogs is opposed by 45 per cent of the hunters and is not recommended.
19. A hunting season from November 15 to January 31 is recommended.
20. Hunters can help increase raccoons by preserving den and nut-bearing trees, eliminating pollution, backing good soil conservation practices, preventing unnecessary fires, planting food plots, damming smaller streams to form pools, erecting den boxes, and eliminating unlawful and unsportsmanlike hunting practices.

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